DOCUMENT RESUME

ED 334 428 CE 058 487

TITLE High Tech Center. Vocational Education Resource Package.
INSTITUTION Evaluation and Training Inst., Los Angeles, Calif.
SPONS AGENCY California Community Colleges, Sacramento. Office of the Chancellor.
PUB DATE 91
NOTE 141p.; For related documents, see CE 058 483-489.
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052)

EDRS PRICE MF01/PC06 Plus Postage.
DESCRIPTORS *Assistive Devices (for Disabled); Community Colleges; *Computer Literacy; *Computer Science Education; Demonstration Programs; *Disabilities; Head Injuries; Hearing Impairments; Learning Disabilities; Microcomputers; Normalization (Handicapped); Physical Disabilities; Program Descriptions; Program Guides; *Program Implementation; Special Needs Students; Technological Advancement; Two Year Colleges; Visual Impairments
IDENTIFIERS *Adapted Computer Technology (Disabled); California Community Colleges; High Tech Centers (Disabled)

ABSTRACT

This Vocational Education Resource Package (VERP) was developed to provide materials useful in replicating an exemplary vocational education program for special student populations in the California Community Colleges. This VERP provides information on the High Tech Center for disabled students. Part I is a general overview of the VERP project, including a list of the packages produced. Part II presents an overview of the program, including its history, applicability, activities, overall effectiveness, and main features. Part III is a reprint from the EDUCOM Strategies Series on Information Technology--a chapter from the book, "Transforming Teaching with Technology: Perspectives from Two-Year Colleges," which deals with the High Tech Center program and its future in the California Community College system. Part IV is a reprint of a study of the High Tech Centers. It gives insight into the characteristics of disabled students at the High Tech Centers and the evidence of effectiveness of the program in meeting the educational needs of special students. (YLB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

J Smith

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

CE058487

VOCATIONAL EDUCATION RESOURCE PACKAGE

HIGH-TECH CENTER

This package is designed to facilitate the adoption of a program for disabled students developed jointly by the California Community Colleges' Chancellor's Office, the California Department of Rehabilitation, the California Health and Welfare Agency, and the Community College Foundation

Prepared for the
Chancellor's Office, California Community Colleges

by

Evaluation and Training Institute
Los Angeles, California
1991

This project was supported by Vocational Education Act funds. The opinions expressed herein do not necessarily reflect the position or policy of the California Community Colleges Chancellor's Office or the U.S. Department of Education, and no official endorsement should be inferred.

TABLE OF CONTENTS

PART I: GENERAL OVERVIEW 1

Introduction 1
History of VERPs 1
Development of VERPs 1
VERPs That Were Produced 2

PART II: OVERVIEW OF THE PROGRAM 4

History of the Program 4
Purpose of the Program 4
Program Funding and Organization 5
Main Features of the High Tech Center Training Unit 6
Adapted Computer Technology 6
Orthopedic Disability 6
Visual Disability 7
Deafness or Hearing Impairments 7
Acquired Brain Injury 7
Learning Disabilities 8
Acquired Brain Injury/Learning Disability Objectives 8
Foundation and Problem Solving Skills 8
Educational and Productivity Skills 9
Campus Resource Integration 9
Information Source 9

PART III: RESOURCE INFORMATION 10

PART IV: RESEARCH STUDY OF THE HIGH TECH CENTERS 47

PART I: GENERAL OVERVIEW

INTRODUCTION

Vocational Education Resource Packages (VERPs) contain information necessary for the adoption and implementation of existing exemplary vocational education programs at the California Community Colleges. These programs target special student populations: disabled students; single parents and displaced homemakers; disadvantaged students; and, those with limited English proficiency. VERPs enable the dissemination of these special programs to interested colleges and provide a model and resource materials for their adoption. This VERP provides information on The High Tech Center for disabled students.

HISTORY OF VERPs

The Carl D. Perkins Vocational Education Act (VEA) of 1984 placed a dominant emphasis on providing access to quality programs to groups of students traditionally underrepresented students in vocational education. A Planning and Future Study Committee consisting of representatives of the Chancellor's Office and local colleges predicted that the numbers of special population students at the community colleges, including the disabled, the disadvantaged, single parent/displaced homemaker, and limited English proficient, will grow significantly over the remainder of this century. In early 1990, as one effort to serve these categories of students, the Chancellor's Office funded a VEA special project to develop and disseminate a comprehensive resource model for special student populations. This VERP is a final product of that project.

DEVELOPMENT OF VERPs

Model programs were identified through a variety of methods: a phone survey of all 107 California community colleges identified a number of prospects; Chancellor's Office Special Projects were reviewed for their potential; and nominations were made by the members of the project Advisory Committee. Materials were requested on these programs and follow-up calls were made to gather additional information. The following criteria were used to determine if a program was eligible for development as

a VERP: 1) the program had documentation; 2) there was evidence of its effectiveness, usefulness or impact; 3) it had been developed, at least in part, with VEA funds; 4) it possessed the ability to be transported to and implemented at other colleges; 5) the program had been developed since 1980; and, 6) it targeted at least one of the four special student populations.

From the programs that were identified, the Advisory Committee selected 10 exemplary programs for development as VERPs. The developer's materials, existing program documentation, and other useful supplemental materials are included for use in replicating the program.

VERPs THAT WERE PRODUCED

The following 10 VERPs were produced:

I. For Displaced Homemakers and Single Parents:

SPACE II - Single Parent Adults Choosing Education

II. For Disadvantaged Students:

A. Career Beginnings

B. IN-D'MAND - Internships for Disabled, Minority, and Disadvantaged Students

III. For Limited English Proficient Students:

A. AERO - Advancement of Ethnic Representation and Opportunity

B. Bilingual Welding and Automotive

C. Outreach and Orientation for ESL Students

IV. For Disabled Students:

A. Basic Food Service Training

B. Center for the Vocationally Challenged - Business PC and Computer Programming Training

C. High Tech Center

D. Project WorkAbility

PART II: Overview of the Program

History of the Program

In the fall of 1984, the disabled students services program at Monterey Peninsula College began offering courses in word processing for students with disabilities. Six students enrolled in the first course offering. Enrollment grew rapidly with each successive semester as students who had never before considered postsecondary education began to enroll in adaptive computer word processing programs. They often continued on with regular classes at the college.

Soon, the demand for adaptive courses outgrew the capacity of the program. In order to meet the growing demand, the High Tech Center was developed as a facility dedicated to providing students with disabilities access to technologies that would allow them to compete successfully in postsecondary education and workplace settings.

In late 1985, the statewide director of the Disabled Student Programs and Services (DSP&S) unit for the California Community Colleges Chancellor's Office determined that the High Tech Center program was a valuable resource that should be made available statewide. A large-scale research, evaluation, and training facility was established in Cupertino for use by DSP&S program directors at all 107 California community colleges.

To date, more than 70 California community colleges have opened High Tech Centers on their campuses. In 1989-90, more than five thousand students participated in the program, making it the largest project ever undertaken by postsecondary education to provide students with disabilities full access to microcomputers and to instructional and supportive technologies.

Purpose of the Program

The High Tech Center is dedicated to meeting the needs of disabled students so that they may learn to effectively use computer systems. The center provides disabled students with access to technologies which allow full participation in postsecondary education and employment settings.

3

Carl Brown, Director of the Office of Adapted Computer Technology for the California Community Colleges Chancellor's Office and coordinator of the High Tech Center for the Disabled, states:

> *"The High Tech Center program is an outstanding example of what can be accomplished when state agencies work cooperatively to enhance the educational and employment opportunities of persons with disabilities. The assistive computer technologies provided by this program point the way towards a bright new future for persons who are deaf or hard-of-hearing, have acquired brain injuries, or have visual, orthopedic, or learning disabilities."*

Instead of building a facility by simply acquiring "traditional" adaptive devices, the originators established a primary goal of the replacement of expensive hardware-based computer modifications (special keyboards, large-screen display monitors, etc.) with high-quality, software-based adaptations. In this way, the students can acquire the individual software programs at a cost much lower than that of traditional adaptive hardware devices. The student can then make almost any computer station suitable to his or her needs.

Program Funding and Organization

The High Tech Center program is a cooperative undertaking between the California Community Colleges Chancellor's Office, the California State Department of Rehabilitation, the California Health and Welfare Agency, the Community College Foundation, the state-wide system of California Community Colleges, and other participating agencies. The High Tech Center Training Unit, located in Cupertino, is the central support facility for the state-wide network of High Tech Centers.

A funding mechanism was established through a federal Establishment Grant. Community Colleges provide a 25 percent cash match against the cost of implementing a High Tech Center facility on their campuses. The colleges agree to enroll at least 51 percent Department of Rehabilitation clients in their High Tech Center programs. In exchange, they receive computers, printers, adaptive equipment, and software valued at approximately $ 23,000. Additionally, colleges can request up to two full time instructional specialists in the areas of adapted computer technology (ACT) and/or acquired brain injuries/learning disabilities (ABI/LD). Three days of intensive training is provided for each of these specialists, plus extensive ongoing telephone support from the central unit in Cupertino.

Main Features of the High Tech Center Training Unit

The Center conducts specialized training in the areas of Adapted Computer Technology and Acquired Brain Injury/Learning Disability software applications. It also provides daily technical support to more than one hundred and fifty professionals working at High Tech Centers across the state. Additionally, the facility publishes and distributes the bi-monthly *High Tech Center News*, and operates an electronic bulletin board system to further enhance communication between field sites and the Center. Both the newsletter and the bulletin board system are dedicated to issues related to computer access for the people with disabilities.

The High Tech Center also conducts ongoing research into new and emerging access and instructional technologies and thus functions as an information resource for the entire postsecondary educational system.

These services are offered at no charge to all California Community Colleges and participating educational agencies.

Adapted Computer Technology

Persons with orthopedic, visual, or learning disabilities frequently experience great difficulty either seeing a computer screen or manipulating a keyboard. Adapted Computer Technology (ACT) refers to any computer program or device which restores an individual's ability to see a computer screen or use a keyboard. The ACT component of the program employs high quality software adaptations which are easy to use, commercially available, and function transparently with commonly used software programs (Lotus, WordPerfect, dBase, etc.).

Orthopedic Disability

The ACT component provides specific adaptations for students with mild to moderate orthopedic disabilities. Software and hardsystems provide alternative computer keyboard methods. Depending upon the nature and severity of the disability, adaptations might be a simple as stopping the automatic key repeat feature found on many keyboards or as complex as combining predictive "smart" word processing systems, automatic spell-checkers, and keyboard control programs to produce highly automated writing environments.

The High Tech Center has been instrumental in introducing "smart" word processing systems. A "smart" word processor analyzes the content and word frequency patterns

of the sentence under construction, anticipates the entire word or phrase based on the first two or three letters, then completes it with a single keystroke.

Visual Disability

For students with vision difficulties, the ACT component provides a variety of effective, easy-to-use methods for viewing enlarged text directly on the computer monitor. Individuals with low vision gain access to the whole gamut of personal computer programs when utilizing adaptations that enlarge screen text and graphics through a wide range of magnifications. Low-vision adaptations are remarkably easy to learn; most users master the fundamentals in less than fifteen minutes.

Advanced speech synthesizers combined with screen reading programs enable blind persons to "see" computer screens through auditory feedback. Synthesizers "speak" what screen-reading programs "see" on the screen. This combined technology enables persons with visual disabilities to write documents with word processors, enter numbers in spreadsheets, retrieve data from databases, or use a host of other common computer applications.

Synthesizer and screen reader combinations also allow persons with learning disabilities to hear what they have written. The shift of error identification and correction processes from a visual mode to an auditory mode can be enormously useful to persons with visual processing deficits. Enlarging the size of the screen text and/or changing the background or text color also enhances visual perception.

Deafness or Hearing Impairments

Persons who are congenitally deaf and those with limited hearing often experience difficulty gaining facility with written language. In addition to special word processing systems, the ACT component employs software which translates written English into graphic finger spelling signed on the computer screen. With this configuration, vocabulary lists, for example, might be entered into the computer to provide practice with both the signed and English orthographic versions of a given word.

Acquired Brain Injury

The Acquired Brain Injury/Learning Disabilities (ABI/LD) component of the High Tech Center dedicates itself to improving academic performance, personal productivity and employability of students with learning disabilities and/or acquired brain injuries.

The Consortium for the Study of Programs for the Brain Injured defines acquired brain injury (ABI) as "an acquired impairment of medically verifiable brain functioning." Many students with acquired brain injury experience deficits in attention and concentration. Extraneous stimuli distract them easily and they have difficulty concentrating. Memory deficits are common and result in difficulty acquiring new information. Other areas of cognitive processing which may be affected by ABI include: speed of thinking, receptive and expressive language skills, psychosocial behavior, mental flexibility, impulsivity, motor/movement, vision, hearing, and other physical abilities.

Learning Disabilities

In the California Community College system, learning disability (LD) in adults is defined as "a persistent condition of presumed neurological dysfunctions which may also exist with other disabling conditions. This dysfunction continues despite instruction in standard classroom situations." Students with learning disabilities demonstrate a number of common characteristics. While no one student will exhibit all of them, some of these characteristics include: difficulty focusing and sustaining attention, inconsistent performance on tests, limited expressive or receptive vocabulary, misnaming of objects using a similar but incorrect word, difficulty repeating auditorily presented material, difficulty following complex oral directions, difficulty with reading and written language, and problems with fine-motor movement.

Acquired Brain Injury/Learning Disability Objectives

The development or retaining of cognitive, educational, study, and productivity skills enhances students' success in mainstream courses and work environment. The ABI/LD software and activities are used in conjunction with other academic support services on campus. Computer software programs provide skill development in four areas: Foundation Skills, Problem Solving and Learning Strategies, Educational Skill Building, and Productivity and Compensatory Skills.

Foundation and Problem Solving Skills

Attention, concentration, memory, differentiation, and sequencing make up basic cognitive processing skills. The foundation skills are required to ensure full participation by students in the learning activities that follow. Some programs for students with brain injuries have been specially developed, but most are commercially available.

Problem solving and learning strategies are taught to help students retrieve information and solve a wide variety of practical, educational and life skills problems. Computer programs in this area build from simple to complex concepts. They focus on learning to select, combine and implement problem solving and learning strategies.

Educational and Productivity Skills

Productivity and Compensatory Skills software trains or supports personal productivity, both for educational activities in mainstream classes and in work related needs. Students practice tasks requiring executive functions such as organization and management. Compensatory strategies and software help students increase their task efficiency and work completion. Software includes word processors, spell checkers, outliners, calculators, budget managers, and personal time management systems.

Computer software provides instruction in basic educational skills using tutorials, simulations, and practice. Students learn to apply study skills, information gathering, and reference use to actual coursework. These educational tasks incorporate language arts, reading, and mathematic processes.

Campus Resource Integration

Staff from all High Tech Center sites are trained to coordinate software with existing educational resources in order to provide a comprehensive program for students. This coordinated system provides students with the technological tools necessary to work toward independence and greater academic or vocational success.

Information Source

Carl Brown
High Tech Center Training Unit
21050 McClellan Road
Cupertino, California 95014

(408) 996-4636

PART III: Resource Information

The following section is a reprint from the EDUCOM Strategies Series on Information Techonology. It is a chapter from the book Transforming Teaching with Technology: Perspectives from Two-Year Colleges by Kamala Anandam, editor. The chapter deals specifically with the High Tech Center program and its future in the California Community College system.

Transforming Teaching with Technology: Perspectives from Two-Year Colleges

Kamala Anandam,
Editor

EDUCOM Strategies Series on Information Technology

Chapter 13

High Tech Centers for the Disabled: The Future of Computer Access in the California Community Colleges

Carl Brown
Director
Marcia Norris
Adapted Computer Technologies Training Specialist
and
Jill Rivers
Coordinator, Acquired Brain Injuries and Learning Disabilities

Introduction

California has a long history of providing specialized educational programs for the disabled. As early as 1860, a state-supported school for deaf and blind children was established in San Francisco. Over the next century, an additional twenty-eight special-education facilities were developed to meet the instructional needs of children with disabilities.[1] Although special services for students with disabilities were available at the kindergarten through twelfth-grade levels of the public education

system in California, little opportunity existed for disabled students (students with low vision, blindness, learning disability, speech/language disability, acquired brain injury, physical disability, developmental disability, hearing loss, or deafness) in the state's systems of public postsecondary education.

Motivated in part by the newly enacted federal Rehabilitation Act, which read that "no otherwise qualified handicapped person, shall, on the basis of handicap, be excluded from participation in, be denied the benefits of, or otherwise be subjected to discrimination under any program or activity that receives or benefits from federal financial assistance,"[2] the California legislature embarked on a series of landmark reforms designed to enhance educational opportunities for the disabled in each of the three public segments of higher education.

In 1976, the passage of Assembly Bill 77 by the California legislature marked a turning point in the lives of thousands of disabled Californians. This bill authorized the development of state-funded support services and instruction in the California community colleges for students with disabilities. Prior to the bill's passage, the community college system, with a statewide enrollment on its 106 campuses of nearly one million students, was attended by fewer than five thousand disabled students. Within the twelve years following the passage of Assembly Bill 77, the number of disabled students attending California community colleges has grown to nearly fifty thousand.[3]

Although disabled students are attending California community colleges in ever-increasing numbers, their level of academic preparation for higher education is often inadequate. Whether this is a consequence of limited educational opportunity in the K-12 sector or an artifact of disability on the educational process is an issue that is yet to be determined. Under the mandate of Assembly Bill 77, the California Community Colleges Chancellor's Office has, through its Disabled Students Programs and Services (DSP&S) unit, instituted a number of statewide programs intended to assist disabled students in the successful completion of their postsecondary education. Among the newest of these programs is the statewide network of High Tech Centers for the Disabled.

For disabled and nondisabled students alike, access to computers is becoming an increasingly critical factor in the successful completion of higher education. Early in the 1960s when microcomputers first began to appear, they were hailed by many educators as the great equalizers —

devices that would finally allow disabled students to compete as equals in the classroom. These initial optimistic expectations were never realized. Many disabled students found computer access difficult or impossible.

One of the principal reasons for that difficulty lay in a basic design characteristic of computers. The primary interfaces between people and computers are the screen and keyboard. These interfaces have often been partially to totally obstructed for students with visual and/or orthopedic disabilities, depending on the nature and severity of their disabling conditions. Within the last three years, however, new technologies have emerged that allow many disabled individuals to achieve full and unencumbered access to computer systems. Generally referred to as adapted computer technology (ACT), these new systems provide alternative methods for viewing the computer screen or using the computer keyboard. Adapted computer technology systems generally are software-based, are highly flexible, are able to work with standard commercial software (*WordPerfect*, *dBASE*, *Lotus*, etc.), are able to function on PC or Apple Macintosh computers (although not interchangeably), and cost less than one hundred dollars per program.

The High Tech Center for the Disabled of the California Community Colleges Chancellor's Office has been instrumental in the development and implementation of this new generation of adapted computer technology. Through a $5.5-million grant from the California State Department of Rehabilitation, between October 1986 and June 1988 a network of fifty-one High Tech Centers for the Disabled was established in California community colleges across the state. The intent of the program is to provide low-vision, blind, deaf and hard-of-hearing, learning disabled, physically disabled, and brain injured students with training in, and access to, supportive technologies that allow them to compete effectively in both the academic and workplace environments. The history, structure, and purpose of this program is an excellent example of the innovative ways in which microcomputers can be employed in a community college setting.

In the fall of 1984, the disabled students services program at Monterey Peninsula College began offering courses in word processing for students with disabilities. Six students enrolled in that first course. Each time the course was offered, enrollment grew. Much to our amazement, disabled individuals who had never considered postsecondary education were enrolling at Monterey Peninsula College to learn word processing with

adapted computers. And they were staying on to become successful participants in mainstream courses.

When demand for the course reached epic proportions, it was time to stop and think carefully about what was happening and what we were doing. That we had discovered a tremendous unmet need was obvious, but what was it? On closer examination, it became apparent that we had tapped into a powerful desire of people with disabilities — the desire to function productively in both the academic setting and the working world. In response to this need, we developed the High Tech Center for the Disabled, a facility dedicated to providing students with disabilities access to technologies that would allow them to compete successfully in postsecondary educational and workplace settings.

Instead of building a facility by simply acquiring "traditional" adaptive devices as if they were the only options available, we decided to determine what an ideal adaptation ought to do, and we then set out to find or create it. We established as one of our primary goals the replacement of expensive hardware-based computer modifications (special keyboards, large-screen display monitors, etc.) with high-quality, software-based adaptations.

Basic Criteria for Selecting Access Technologies

With these goals in mind and using our experiences with the needs of disabled students as guidelines, we formulated the following set of criteria for evaluating possible adaptive technologies.

- The adaptation must be able to provide the disabled individual with significantly improved access to microcomputers. The multitude of tiny frustrations associated with the constant use of clumsy adaptations regularly prevented disabled students from enjoying the labor-saving benefits of computer access.

- The adaptation must be able to function with industry-standard software, such as Lotus, WordPerfect, and dBASE. By providing access to commercially available software and by transitioning disabled students into a wide range of courses that used computers (e.g., accounting, drafting, word processing, and computer science), we hoped to begin breaking down a long-standing equation concerning computers and the disabled, namely, that a person with a disability plus a computer equaled a computer programmer.
- The adaptation must be able to function concurrently and harmoniously with many other adaptations. Disabling conditions frequently require the simultaneous use of several adaptations in order to restore full access to microcomputers. Disabling conditions come in a variety of configurations; it made sense that adaptations should also. We wanted to develop a set of adaptations that could be assembled like building blocks into a myriad of different configurations.
- The adaptation must be easy to teach, learn, and maintain. With rare exceptions, the disabled individual should be trained to use the access device in less than thirty minutes. A computer adaptation requiring a month or more of an instructor's time to learn and additional months to teach to students is not an effective tool. Even the most dedicated of staff simply do not have enough hours in a day to deal with such equipment.
- The adaptation must be affordable — generally costing less than three hundred dollars. There is little point in teaching a disabled individual to use an adaptive device that he or she cannot afford to purchase.
- The adaptation must be able to function on the IBM PC, PC-compatible, or Macintosh series of computers (although not interchangeably between PC and Macintosh computers).

Program Development

In this way, we established the conceptual framework of the High Tech Center for the Disabled at Monterey Peninsula College. During the next two years, we explored, experimented with, tested, and evaluated a variety of software and hardware adaptations. Many were failures. Some worked moderately well under controlled conditions. A few proved to work very well indeed.

Over the course of those two years, word of Monterey Peninsula College's High Tech Center and of disabled students' phenomenal response to the program began to circulate, first to neighboring community colleges and then to colleges across the state. The number of visitors to the program increased rapidly, with visiting faculty sometimes occupying more than half the classroom. In late 1985, two events critically altered the future of computer access for disabled students in California community colleges.

After visits to the High Tech Center at Monterey Peninsula College, the statewide director of the Disabled Students Programs and Services (DSP&S) unit for the California Community Colleges Chancellor's Office determined that the High Tech Center program was a valuable resource that should be made available statewide. This meant establishing in Sacramento a large-scale research, evaluation, and training facility that would be available to DSP&S program directors at all 107 California community colleges.

At about that same time, the educational consultant for the California State Department of Rehabilitation (DR) became convinced that improved computer access could be of great benefit to DR clients enrolled in the community colleges. The cost-effectiveness and software transparency of the High Tech Center approach solved many of the access problems DR clients had encountered when using computers in the past. The Department of Rehabilitation was also particularly interested in the capacity of assistive technology to provide important new avenues of opportunity for persons with acquired brain injuries or learning disabilities.

Program Funding and Organization

A funding mechanism was identified in the form of a federal Establish-

ment Grant. Through a cooperative undertaking of the California State Department of Rehabilitation and the California Community Colleges Chancellor's Office, with funding administered by the Community College Foundation, an innovative plan was developed to meet the needs of both DR and the Chancellor's Office.

Community colleges wishing to participate in the High Tech Center Establishment Grant program would provide a 25 percent cash match against the cost of implementing a High Tech Center facility on their respective campuses. Participating colleges would also agree to make every effort to enroll a preponderance (51 percent) of DR clients in their High Tech Center programs. In exchange, they would receive computers, printers, adaptive equipment, and software valued at approximately twenty-three thousand dollars. Additionally, colleges could request up to two full-time instructional specialists in the areas of adapted computer technology (ACT) and/or acquired brain injuries/learning disabilities (ABI/LD). Three days of intensive training would be provided for each of these specialists, plus extensive ongoing telephone support from the newly established High Tech Center in Sacramento.

The High Tech Center Establishment Grant program has proven to be remarkably successful. In operation since 1987, the project's total funding currently exceeds $5.5 million. As of 1989, there are fifty-eight High Tech Centers across the state. Fifty-one of these are located in California community colleges, with the remaining seven at California state universities, the University of California, and K-12 campuses across the state. In 1989–90, more than five thousand students will participate in the program, making it the largest project ever undertaken by postsecondary education to provide students with disabilities full access to microcomputers and to instructional and supportive technologies.

Faculty/Specialist Training

One of the most critical elements in the development of this new statewide resource has been the training of instructional specialists in the use computer-access technologies. Confident, competent, and well-informed instructors are critical to the successful operation of the entire High Tech Center program. Without such staff to provide instruction in the use of state-of-the-art computer-access and educational technologies,

disabled students are denied a major support structure in their efforts to complete postsecondary education. Additionally, well-trained staff are essential if California community colleges are to comply with state guidelines regarding recruitment of underrepresented students, provide appropriate counseling and academic support services for students with disabilities, apportion resources to meet the needs of various disability groups, and respond effectively to students' comments and criticisms concerning level of satisfaction with services provided.

Assuring the success of faculty involved in the High Tech Center project is of critical importance. Most major studies on effective innovation in postsecondary education indicate that the involvement and support of faculty are the key elements in the success or failure of the program. RAND Corporation's landmark study of one hundred successful projects in education found that in all projects, the majority of time and resources was invested in teacher retraining and support.[4]

For many instructors in postsecondary special education, the decision to acquire specialized computer literacy skills (a decision made either voluntarily or by instructional necessity) can be both intimidating and rewarding. It can be intimidating in the sense that the instructor will be required, perhaps for the first time in many years, to conduct classes in a subject area in which he or she feels little in the way of traditional subject mastery. The decision can be rewarding in the sense that the technologies involved create educational opportunities never before available to students in typical postsecondary special-education classes. As one High Tech Center specialist put it:

> As a professional educator, proficiency and competency had always been the hallmarks of success within my discipline. To operate on the very edge of what I knew went against all my training. I had always regarded operating from such a position as being unprofessional. And yet, because adapted computer technology is so profoundly important, many individuals who have rich years of teaching behind them will be asked to operate, initially, from just such a position. As I have developed the skills which I use today on a daily basis in the High Tech Center, I have come to understand the importance and rightness of this challenge. The richness of merging prior competencies with the presentation of the

> amazingly simple but versatile adapted technologies is truly a creative synthesis.[5]

Research indicates that educators, and students in general, seem to learn highly technical, computer-related subjects more easily when familiar analogies are employed. German and Soderston postulated that familiar analogies make use of existing cognitive frameworks and thus provide a better integration of new and highly abstract technical information.[6] The authors found that the use of analogies significantly increased comprehension and recall scores of test subjects attempting to learn computer terminology for the first time. Although these researchers employed a relatively small adult sample (n=14), the difference between the analogy and the nonanalogy groups was significant at a level of $p < .05$.

Additionally, for many instructors, the perceived loss of professional competency and certainty that can temporarily occur in a situation of new learning may be profoundly threatening to self-image.[7] It is, therefore, vitally important to establish a learning environment in which there is simultaneously a complete acceptance of the participant's present lack of knowledge and a total certainty that he or she will acquire that knowledge over the course of the training period.

These findings tend to support the instructional methodologies employed by training staff at the High Tech Center. During the intensive three-day training received by both ACT and ABI/LD instructional staff, every effort is made to present complex new concepts in terms that are familiar and "make sense" to participants. Class sizes are small, generally less than twelve trainees. A student-to-instructor ratio of four-to-one is maintained. Training sessions begin at 9:00 a.m. and continue until 5:00 p.m. During the course of the training, participants are encouraged to think of their current students for whom the technologies could be useful. A trainee learning to use a keyboard access system might, for example, be encouraged to explore the possibilities of the device by creating a unique keyboarding environment designed to meet the needs of a student he or she works with regularly. The use of technical jargon, acronyms, and "buzz words" is intentionally limited, and often is completely absent, during High Tech Center training.

An evaluation of survey responses collected from 214 instructional specialists trained by High Tech Center staff between April 1987 and September 1988 appears to validate the effectiveness of the training techniques employed by High Tech Center staff. The great majority of partic-

ipants (94 percent) reported that information covered during the trainings was presented in a clear and understandable manner. Approximately 63 percent of trainees felt that the pace of training was "just right"; 20 percent felt that it was a little too fast; and 13 percent thought that it was a little too slow. These variations are probably attributable to participants' previous computer experience.

Confidence levels before training varied widely. The majority of participants (58 percent) reported low confidence levels in their ability to use the technology employed by the program. Approximately 15 percent reported feeling quite confident in their ability, while nearly 24 percent had only moderate levels of confidence. Confidence levels after training were dramatically different. Approximately 76 percent of the participants now reported feeling quite confident, while 21.5 percent indicated they felt moderately confident, and only 1.4 percent reported feeling low levels of confidence.

Although these statistics present substantive evidence of the success of the High Tech Center training methods, they fail to provide any real insight into the types of instructors who become successful High Tech Center specialists. Marcia Norris, formerly a High Tech Center instructor for three years at Monterey Peninsula College and now a training specialist at the Sacramento facility, provides us with a much more personal perspective.

> What made me a successful High Tech Center instructor? When I look back, several things come to mind. As a High Tech Center specialist, I discovered that two kinds of competencies were vital: a background in special education and a willingness to learn on the job.
>
> It is interesting to note that instructors who had not had experience in special education, but who were extremely knowledgeable technically, tended to leave the field after the first year because of the essentially nontechnical nature of a High Tech Center instructor's position. Almost no specialists with backgrounds in disability left High Tech Center positions.
>
> Although learning "on the job" is not the usual way in which I had been used to working, in actual practice it proved to be

a highly effective way of helping me learn and use a new technology.

The fact that the High Tech Center used a small, fixed array of hardware and software meant that the amount of new information I needed to master was manageable. Over the expanse of two semesters of day-in and day-out use, mastery of this relatively small amount of technology resulted in a deep and thorough knowledge of the programs.

Three important factors have emerged as a result of my intense instructional interaction with a small, fixed amount of software and hardware. (1) I was able to develop an in-depth understanding of the basic computer-access needs of disabled individuals. (2) My prior teaching experience was easily adapted to this new environment and I experienced a sense of new creativity. (3) My new technical skills allowed me to intelligently evaluate types of access and instructional technologies other than those provided by the High Tech Center.

Services Provided by the Adapted Computer Technologies Component

Orthopedic Disability

The ACT component provides specific adaptations for students with mild to moderate orthopedic disabilities. Software and hardware systems provide alternative methods for using the computer keyboard. Depending on the nature and severity of the disability, the adaptation might be as simple as stopping the automatic key repeat feature found on many keyboards or as complex as combining predictive "smart" word-processing systems, automatic spell-checkers, and keyboard control programs to produce highly automated writing environments. A "smart" word processor analyzes the content and word frequency patterns of the sentence under construction, anticipates the remainder of the word or phrase based on its first two or three letters, then completes the word or phrase with a single keystroke.

Visual Disability

For students with low vision, the ACT component provides a variety of effective and easy-to-use methods for viewing enlarged text directly on the computer monitor. Individuals with low vision can use the majority of personal computer programs by employing adaptations that enlarge screen text and graphics through a wide range of magnifications. Low-vision adaptations are remarkably easy to learn; most users master the fundamentals in less than fifteen minutes.

Advanced speech synthesizers combined with screen-reading programs enable blind people to "see" the computer screen. The synthesizer "speaks" what the screen-reading program "sees" on the screen. This technology enables a blind person to write a document with a word processor, enter numbers in a spreadsheet, retrieve data from a database, or use a host of other common computer applications. The synthesizer and screen-reader combination also allows a learning-disabled person to hear what he or she has written. Moving the error identification and correction process from a visual to an auditory mode can be enormously useful to people with visual-processing deficits. Visual perception can also be enhanced by enlarging the size of the screen text or by changing the background or text color.

Deafness or Hearing Impairments

People who are congenitally deaf, or who have limited hearing, often experience difficulty gaining a facility with written language. In addition to special word-processing systems, the ACT component employs software that translates written English into finger spelling that is signed on the computer screen. Vocabulary lists, for example, can be entered into the computer to provide practice with both the signed and the English version of a given word.

Acquired Brain Injury

In *The ABI Handbook: Serving Students with Acquired Brain Injury in Higher Education*, the Consortium for the Study of Programs for the Brain Injured in California Community Colleges defined acquired brain injury (ABI) as "an acquired impairment of medically verifiable brain functioning resulting in a loss or partial loss of one or more of the following:

cognitive, communication, motor, psychosocial, and sensory/perceptual abilities." Deficits in the preceding functions are characterized as follows:

- Cognition: impaired memory function, attention, concentration, judgment and problem solving, mental flexibility, organizational thinking skills, spatial orientation and information;
- Communication: impairment of speech, language and pragmatics (*pragmatics* is defined as the appropriate use of semantic and nonsemantic rules governing communication);
- Motor function: limitation in locomotion or motor functions and/or physiological dysfunction of a body part or system;
- Psychosocial abilities: untoward social behavior or impaired psychodynamics that limit or impede learning, interpersonal relationships, coping strategies and goal-directed behavior;
- Sensory/perceptual abilities: deficiencies in primary perceptual systems such as visual, auditory and tactile.[8]

Computers with the appropriate software, and adaptive devices if needed, can make writing and other learning tasks more efficient for students with acquired brain injuries. Computers are particularly helpful in visuo-spatial and attending tasks, which are often areas of need for students with ABI. The ability of computers to control the presentation, timing, type, and complexity of a task based on the direct feedback of the student's ability to respond makes the computer environment ideal for cognitive retraining. But even though computers are extremely useful, they are not capable of replacing the human interaction so necessary to these students.

Learning Disability

In the California Community College system, learning disability (LD) in adults is defined as "a persistent condition of presumed neurological dysfunction which may also exist with other disabling conditions. This dysfunction continues despite instruction in standard classroom situations." A number of characteristics are common to students with learning disabilities: difficulty focusing and sustaining attention, inconsistent performance on tests, limited expressive or receptive vocabulary, misnaming

of objects using a similar but incorrect word, difficulty repeating auditorily presented material, difficulty following complex oral directions, difficulty with reading and with written language, and problems with fine-motor movement. No one student will exhibit all of these characteristics.

Students with learning disabilities benefit from using word processors with on-line spell-check and thesaurus programs. An on-line spell-check program monitors what is being typed and provides instant feedback when errors occur; a thesaurus is one keystroke away and will enter a synonym of choice. The use of spell-check and thesaurus programs allows learning disabled students to spend time on content and organization of documents.

Some students with learning disabilities also benefit from using the adaptive technology for blind students: a screen-reading system and a speech synthesizer. Students with learning disabilities may now edit by ear rather than by eye. Other students with good print-reading skills but poor spelling skills may benefit from predictive word processors. Students may also benefit from the large-print system used by low-vision students; other students may benefit from word processing or editing with talking large print — a combination of several adaptive strategies, the technologies used by blind students and by low-vision students.

The various adaptive technologies employed by students with learning disabilities illustrate the efficacy of the High Tech Center premise that technology must be versatile and adaptable.

Services Provided by the Acquired Brain Injury/Learning Disabilities Component

The acquired brain injury/learning disabilities (ABI/LD) component of the High Tech Center is dedicated to improving the cognitive functioning, academic performance, personal productivity, and employability of students with disabilities, through the use of cognitive retraining and computer-assisted instruction. Students are provided with computer-based tutoring and practice for the enhancement of essential cognitive and academic skills. In addition, utilities are available that can increase productivity and allow students to compensate for certain skill deficits. The computer software utilized in the ABI/LD component provides assis-

tance with the development of study skills and with the time and information management strategies necessary for students to be successful in a community college setting. More specifically, various skills are targeted for development or improvement, including reading and writing for specific purposes; note-taking techniques; memory strategies; test-taking preparation; and decision making and critical thinking. The software employed to address these needs includes word processors, interactive spell-checkers, on-line thesauruses, outliners, budget managers, and personal time and task management systems, as well as basic skills tutorials and vocabulary-building and speed-reading programs.

To be effective, software for the ABI/LD component must incorporate several attributes. Flexibility of presentation variables allows the instructor to set parameters that can be controlled according to the needs of the student (e.g., difficulty level, response input, rate of presentation, presentation of cues). Record-keeping provides for the collection of sufficient data to support the instructor and the student with adequate information to track individual progress. Sufficient feedback is essential to provide immediate information regarding accuracy of response and/or to provide prompts to assist in determining the correct responses. Authoring capabilities allow the instructor or the student to easily customize the content of the software program to meet specific needs (e.g., inserting vocabulary lists to be learned from a mainstream science class). Programs must be easy to use for students with varied levels of acquired brain injury or learning disabilities. Age appropriateness provides the content and graphics that are suitable for community college students. The software utilized in the ABI/LD component supports skill development in the areas of foundation skills, problem-solving and learning strategies, educational skill building, and productivity and compensatory skills.

Foundation Skills

Foundation skills consist of fundamental cognitive processing skills such as attention, concentration, differentiation, sequencing, and memory. Training in these is planned initially to ensure that students can fully participate in the learning activities that follow. Some programs were specially developed for students with brain injuries, but most have broader applicability.

Problem-Solving and Learning Strategies

Generalizable strategies and sequences are taught to help the student retrieve information and solve a wide variety of practical, educational, and life skill problems. Computer programs build from simple to complex concepts. The focus is on learning to select, to combine, and to implement problem-solving and learning strategies.

Educational Skill Building

Computer software provides instruction in basic educational skills using tutorials, simulations, and practice. Students learn to apply study, information-gathering, and reference-use skills to actual coursework. The educational tasks incorporate language arts, reading, and mathematics processes.

Productivity and Compensatory Skills

Software in this area trains or supports personal productivity, both for educational activities in mainstream classes and for work-related needs. The student practices using tasks requiring such executive functions as organizing, managing, and developing tasks. Compensatory strategies and software tools are used to help students increase their task efficiency and work completion.

It is important to remember that although a computer is one of the tools often used in the remediation of cognitive and other learning deficits, it is not a treatment or a strategy in and of itself. The success of any learning intervention is dependent not on the materials or tools used but rather on the skill of the instructor in the use of those tools, on the appropriateness of the tasks, and on the generalization of the learning to the student's everyday life and academic goals.

The Student's Perspective

Disabled students who use computers are as varied and diverse in their personal aspirations and academic and social goals as is any other group of students on a college campus. Many are highly motivated individuals who have clear visions of their futures and advance resolutely toward their goals. Others move through academic life with less certainty and

have grave concerns about what their futures may hold. As a group, however, disabled students who participate in High Tech Center programs are enthusiastic (perhaps for the first time in their lives) about the possibility of successfully completing college, finding work, and carrying on productive, enjoyable lives.

The following profiles were written by disabled individuals who currently use computer adaptations as part of their work environments or who are presently enrolled in High Tech Center programs. The profiles are typical expressions of the excitement and enthusiasm experienced by disabled individuals who are discovering for the first time the freedom of access and academic success provided by these new assistive computer technologies. More than that, the profiles are the expressions of people who see a bright and promising future.

Shannon

Before I came to the High Tech Center, the only computers I knew about were large, expensive (seven-to-ten-thousand-dollar) pieces of hardware with a screen-reading program resident within. I was intrigued with these computers and thought that with a little bit of work, I could learn how to use one efficiently. But what was the sense in thinking about it when they were so far out of my price range? While I had little doubt as to my abilities when I enrolled in the High Tech Center's section for blind students, I was rather cynical about one day being able to own my own system.

For a blind person to use a computer efficiently, he/she must, of course, have a good screen-reading program. The screen reader must be able to mesh effectively with the program that the blind person is working on, whether it be word processing, database management, or a spreadsheet. This means giving the blind person immediate knowledge of cursor position — the page, line, and column number of the cursor in the document and on the physical screen — and anything else that a sighted person has access to quickly with his eyes. It also should be able to distinguish abbreviations from words and, in the case of an abbreviation, pronounce the letters individually rather than trying to pronounce them as a word.

There are many ways that a computer can assist a blind college student. One of the things it can do is give the student a sense of self-worth. With just an extra piece of hardware (the speech synthesizer) and a software

screen-reader, I have learned to operate a system that was designed originally for sighted people. And the best thing about it is that the system is affordable, not like those ten-thousand-dollar computers I mentioned earlier. I am writing this on my own computer, in the comfort of my den. I like that feeling of independence.

Kevin

At the age of thirteen, I lost most of my central vision due to a congenital eye disease called Stargarts. I am now twenty-eight, and I have lost all of the central vision that I had left. Being partially sighted has never really been much of a problem to me with the exception of reading, writing, or seeing blackboards at school.

Upon graduating from high school, I went straight to a community college. There, I painstakingly completed two semesters of college with a 2.8 grade-point average using just my closed-circuit television system. At that time, I felt like I was just spinning my wheels and could do better without school. After quitting school, I worked hard at a resort which was open eight months out of the year. I became tired of what I was doing, though, and realized the value of having a college education, so I left that lifestyle to return to school.

In everything that I do, I always strive for excellence; however, I felt rather inhibited recalling my past experience with school. Then I was introduced to adaptive computers. The computer has allowed me to learn how to type and edit papers in a fraction of the time that it would have taken me otherwise. It has taught me organizational skills, and believe me, if anyone needed organizational skills, I was most certainly the prime candidate! Also, being partially sighted, I really don't read very much because it is so slow and fatiguing. And with my particular eye condition, when I read, oftentimes parts of the words will literally disappear. What I am trying to say is that I am terrible when it comes to spelling. Working with the computer has allowed me to visually see, rather than hear, words — with a great deal of ease. So, essentially, the computer has greatly improved my spelling (thank goodness) and expanded my vocabulary probably tenfold.

I have told you my experience of working with adaptive computers, but I can't really put into words the freedom that it has allowed me. Academically, I feel like they have let me out of a very small dark box with my new-found tool.

Robert

My name is Robert, and I am a quadriplegic with no functional use of my hands. Two years ago I was a deeply concerned and frustrated individual because seemingly all avenues to a productive and meaningful future were blocked by some facet of my life. When I became aware of the innovative High Tech Center for the Disabled, I called Monterey Peninsula College to inquire about the program and was enthusiastically encouraged by the center's staff; hope of finding some feasible way to overcome some of those obstacles was rekindled.

I first learned "Mindreader," a word-processing program which made it possible for me to produce letters and other documents twice as fast and more accurately than I could produce them on an electric typewriter. The program director then asked if I would be interested in a CAD (computer-assisted design) program he was adapting — I was very interested!

I now can draw plans easier and faster with this CAD program than I was able to do when I had full use of my arms and hands. Due to the support and encouragement of so many, and because of the ability of the High Tech Center computer adaptations to accentuate the abilities of the user while forgiving his limitations, I have been given a new outlook on life.

Jay

As has happened with many other LD adults my age (thirty-five), I did not find out about my disability until I was in my late twenties. I still am learning to understand it seven years later. All my life, I knew that there was a difference in me — that I fit differently and did things differently than others.

Until I discovered the word processor, writing remained a painful task, each draft an agony of crossing out, and forced brevity in expression. I had always used a word in place of a sentence, a sentence in place of a paragraph. Even if my ideas flowed, and my fingers were fresh and the pencils sharp, each page looked as if a drunken chicken had staggered across the page. My letters slanted to the right, to the left, above and below the line. Letters slammed into each other, crookedly running off the page.

I never thought of it before, but the keyboard lets the words out of my fingers and flows them across the screen, checks and changes the spell-

ing, reverses the reversals, making me unafraid to write. I gladly accept the limits of this new freedom: I write only at the typewriter at my desk, on the word processors outside my office door, on the PC at home, or on the additional six pounds of battery typewriter I carry with me. It's a small price to pay, being limited to a few locations, because at those places I have the freedom to write, something I never dreamed I would have.

Profile of a High Tech Center Student

In addition to these very personal accounts of the value of High Tech Center programs and technologies, it is useful to have a more general overview of the students who participate. Based on a sample of 550 disabled students who completed High Tech Center courses at a California community college between June 1987 and June 1988, a distinct student profile emerges.

A "typical" High Tech Center student is Caucasian, either male or female, around thirty-two years of age. This individual will most likely have either an orthopedic or a learning disability that occurred or was diagnosed prior to his or her eighteenth birthday.

Although it is quite likely that community college is the highest education level this individual has yet completed, one in three such persons will already have completed more than fourteen years of education. For more than a third of High Tech Center students, the center will be a first introduction to both computers and computer-access systems.

Our student profile suggests that 42 percent of disabled students in the High Tech Center program are on educational tracks leading to employment in two years or less, 31 percent intend to transfer to four-year colleges, and 27 percent have educational goals not specifically related to either transfer or employment.

Our "typical" student experienced better than a 30 percent increase in ease of computer use after the High Tech Center training and reports feeling very confident in ability to use computers and supportive technologies. Depending on the nature of the disability, however, this increase in confidence might be as much as 50 percent or as little as 20 percent.

The great majority of High Tech Center students complete the course with high levels of confidence in their instructors' abilities to answer questions clearly, meet special learning needs, and provide correct solu-

tions to computer-access needs. Additionally, this same majority would agree that computer access will play an important part in graduating from college.

Finally, our "typical" student feels that his or her disability will have a significant, but not dramatically negative, effect on opportunities for employment.

Factors that Impeded or Assisted the Project

Obstacles to Success

The success of the High Tech Center program has not been achieved without difficulty. Some of the issues that have impeded the project's success were quite concrete (shortages of funding, staff, and space), while others were much more subtle. Many of the more concrete obstacles to the development of this project are common to most rapidly expanding programs and have had more impact on program expansion than on actual success.

Finding permanent sources of funding for community college High Tech Center staff positions that were developed under the temporary funding mechanism of the federal Establishment Grant is a major objective of administrative program staff. College-based High Tech Center staff members are an irreplaceable resource who represent a multimillion-dollar investment in both training and professional expertise. Although participating colleges are slowly assuming fiscal responsibility for these individuals as grant funding expires, a substantial portion of overall yearly salary costs remains to be funded. Fortunately, several options appear to be available as both the Community Colleges Chancellor's Office and the California State Department of Rehabilitation continue working cooperatively to secure the future of the High Tech Center program. A final answer to the question of how the professional support staff at the High Tech Center's main office in Sacramento will be funded beyond the grant period may be provided by Governor George Deukmejian's recommendation that permanent state positions for those professional support staff members be included in the 1989–90 state budget.

Community college High Tech Centers frequently find that the demand for services quickly outstrips the capacity of the center. With classroom space at a premium on most community college campuses, High Tech

Centers are often crowded with students and face long waits for needed additional classroom space. Although "expansion grants" intended to provide existing centers with additional or new equipment are periodically available, some colleges are unable to acquire new equipment because they simply have no place to put it.

Perhaps the most serious obstacle encountered by the High Tech Center program has been the subtle, and perhaps even unconscious, belief — held by many individuals — that people with disabilities are fundamentally incapable of being successful, in the traditional socioeconomic sense of the word. A successful business operated by an individual with a disability, a disabled person appointed to a significant government position, the completion of a rigorous academic program by a disabled person — these are still newsworthy items. And their very newsworthiness is testimonial to our surprise that people with disabilities can be successful. If such deeply held and unconscious beliefs exist in an educational setting, they can be particularly insidious. In such a setting, these beliefs often manifest themselves as low expectations by the faculty serving students with disabilities, "dead-end" special-education programs, and the limited transfer of students with disabilities to four-year colleges.

Contributors to Success

Although many factors have contributed to the success of the High Tech Center program, several were particularly important.

Champions

Every project of this sort requires its champions, people who take a special interest in the program and contribute their unique skills and expertise to its success. The High Tech Center project has had more than its fair share of such benefactors. In 1983, when the project was in its most formative and vulnerable stages, it enjoyed the support and encouragement of both Martha Kanter, the director of Monterey Peninsula College's disabled student services program, and Dr. Jack Bessire, then the dean of students. The nature of their support often took very concrete form. Many battles over space and funding for the High Tech Center were championed by these two individuals.

As the program grew, its champions were found at the state level. Keith Foster, the educational consultant from the California State Department of Rehabilitation, and Susan Cota, the statewide director of disabled stu-

dent services for the California Community Colleges Chancellor's Office, were both strong advocates of the program. These two were able to transform their enthusiasm and commitment for the program into administrative support from both Dr. Cecie Fontanoza, the director of the California State Department of Rehabilitation, and Dr. David Mertes, the chancellor of the California community college system. Ultimately, this administrative support was essential to the acquisition of funding at a level sufficient to support the explosive growth of the statewide High Tech Center program.

On a daily basis, the program's most important champions have been and remain the thousands of disabled students who participate in the project, as well as the project's instructional staff of more than 150 enthusiastic and committed individuals. These students and staff members lend a credibility to the functional effectiveness of the program that no administrative testimonial can duplicate.

Interagency Cooperation

The extraordinary level of cooperation between the California Community Colleges Chancellor's Office and the California State Department of Rehabilitation has been a cornerstone of the project's success. The ability of these two agencies to identify a set of common goals (academic success, graduation or transfer leading to employment) and then to solve the various fiscal, organizational, and management issues involved in the realization of those goals is an outstanding example of what can be accomplished when state agencies work cooperatively to enhance the educational and employment opportunities of people with disabilities.

Timing

Clearly, timing has played a significant role in the success of the High Tech Center project — *timing* in the traditional sense of being "in the right place at the right time," and also a kind of national synchronicity of thought. In retrospect, it would appear that a number of significant individuals in the areas of legislation, rehabilitation, and education realized, at virtually the same time, that the potential existed for a vastly improved level of computer access for people with disabilities. Although this realization took many forms, it established a powerful context within which the concept of the High Tech Center could be realized.

Some of the contextual framework for this project was established by

historic legal decisions which mandated that institutions provide equal access to educational opportunities for students under the Civil Rights Act of 1964 and, more specifically, under Section 504 of the Rehabilitation Act of 1973 as amended. This act describes "reasonable accommodation" as the method for ensuring nondiscrimination against people with disabilities.[9]

Across the country, institutions had begun to take broad steps to make education more accessible to students with disabilities. The decade of the 1970s, for example, saw great emphasis on the removal of architectural barriers on campuses. States now have architectural review boards and extensive requirements for the construction of buildings and pathways to accommodate the disabled. Reflecting on what was built in the past, we find it difficult to imagine how our planning could have been so shortsighted as to allow design oversights that barred disabled students from engineering centers or humanities laboratories.

A Word about Legislation

Now that adapted computer technology permits full access to commercially available and instructor-authored software programs, individual microcomputers, and networks, it is reasonable to expect institutions to take these same types of proactive steps to accommodate computer access by students with disabilities. Failure to do so could have legal consequences as equal access and equal opportunity continue as guiding principles in college admissions and academic participation. As a case in point, in the 1979 Supreme Court case *Southeastern Community College v. Davis*, our highest court recognized the emerging needs of the disabled in terms of advances in technology.

> We do not suggest that the line between a lawful refusal to extend affirmative action and illegal discrimination against handicapped persons will always be clear. It is possible to envision situations where an insistence on continuing past requirements and practices might arbitrarily deprive genuinely qualified handicapped persons of the opportunity to participate in a covered program. Technological advances can be expected to enhance opportunities to rehabilitate the handicapped or otherwise to qualify them for some useful

> employment. Such advances also may enable attainment of these goals without imposing undue financial and administrative burdens upon a state. Thus, situations may arise where a refusal to modify an existing program might become unreasonable and discriminatory. Identification of those instances where a refusal to accommodate the needs of a disabled person amounts to discrimination against the handicapped continues to be an important responsibility of HEW.[10]

Further, in *Alexander v. Choate* the Supreme Court stated:

> Discrimination against the handicapped was perceived by Congress to be most often the product not of invidious animus, but rather of thoughtlessness and indifference — of benign neglect. ... For example, elimination of architectural barriers was one of the central aims of the ACT, yet such barriers were clearly not erected with the aim or intent of excluding the handicapped.[11]

The federal government has taken additional legislative action to implement its commitment to improved computer access for people with disabilities. In relating these emerging new technologies to the goals and objectives of affirmative action, Section 504, and the U.S. Department of Education's regulations on Section 504 regarding program accessibility and the provision of auxiliary aids to students with disabilities (34 C.F.R. Part 104), the government has now developed standards that apply to adapted computer technologies. Quoting from a recently released report produced jointly by the Department of Education and the General Services Administration: "On October 21, 1986, the Department of Education (ED) and the General Services Administration (GSA) were directed by Congress (Public Law 99-506) to develop agency procurement guidelines to ensure access to electronic office equipment by individuals with disabilities." The report continues:

> In 1986, Congress re-authorized the Rehabilitation Act of 1973, as amended, (Public Law 99-506) adding Section 508 on electronic equipment accessibility "...to insure that handicapped individuals may use electronic office equipment with or without special peripherals." Congress has mandated

> that guidelines for electronic equipment accessibility be established and adopted and that agencies shall comply with these guidelines with respect to electronic equipment, whether purchased or leased.

These clearly defined access criteria, usage requirements, guidelines, and related access issues compose standards that are now law or administrative rulings. Looking ahead to the likelihood that this kind of legislation will be broadly interpreted to meet the needs of disabled people in general, we find it probable that institutions which receive federal funds and require computer access for all students will need to prepare for such standards in the near future.

Oddly enough, the contextual framework for the High Tech Center project was further strengthened by the general public's recognition of computers as a "normal" part of the educational, office, and professional environment. With the "specialness" of computers erased by familiarity and with the machines now seen in the same general-use category as typewriters and copy machines, a time had arrived when it made sense that everyone, including the disabled, should be able to use computers. The development by IBM and Apple Computer of support facilities for computer users with disabilities, the media coverage these facilities received, and the increasing volume of research papers concerned with computer use by students with disabilities also contributed to preparing the ground for the High Tech Center project.

The Future of Adapted Computer Technology

For disabled students in postsecondary education, the future of adapted computer technology is filled with both promise and peril. Advances in computer technology open some doors while closing (or, more accurately, never really opening) others. Over the coming years, careful consideration will be required in the areas listed below.

Adapted Computer Access to Campuswide Networks

To harness and organize the vast processing power represented by the array of micro-, mini-, and mainframe computers found on many campuses, colleges are rapidly implementing complex networks that link

widely dispersed computer systems into one coordinated assemblage whose resources can be shared by all. At their best, such networks become an integral part of the culture of a college or university. Well-designed and functional networks can provide improved student/faculty communications, access to valuable research data, computer-assisted or -augmented instruction, electronic bulletin board and mail services, a forum for the exchange of information and ideas, access to computerized class registration, and much more. Such networks point squarely at the future of information access, not just on college campuses but in our society as a whole. We are again at a turning point, a critical moment when those with the capacity and opportunity to access vast networks of computerized knowledge will become information-rich, and those who do not have such ability will be information-poor. Knowledge, as the saying goes, is power. In our ever-more-complex world, instantaneous computer access to accurate information is the key to knowledge.

It is vitally important that, when planning such networks, colleges and universities consider the adapted computer-access requirements of their disabled students. Failure to do so could inadvertently exclude such students from a major component of campus life and culture. A number of important questions must be asked:

- If campus networks are accessed via personal computers, what special equipment and/or software will be required to connect the PC to the campus network?
- How will the hardware/software that allows the PC to access the campus network affect the operation of adapted computer access hardware/software?
- Will screen displays of text — for example, on-line card catalogues — be consistently formatted to enhance access for computer users who are blind?
- If the campus network makes extensive use of computer graphics, how will access be provided for blind students whose screen-reading systems are unable to interpret a graphic display?
- What provisions can be made to provide remote access to the network via phone modem for disabled students who may find it more practical to carry out some assignments at home?

- If the network can be accessed only with dedicated computer terminals, what provisions will be made to accommodate the special access requirements of blind, low-vision, or orthopedically disabled students?

Adapted Access Requirements and Computerized Educational Testing

Most major testing companies (College Board, McGraw/Hill, etc.) now have, or are actively developing, computerized versions of most tests. Each of these companies shares a common vision of a time in the not-too-distant future when the majority of testing will be conducted in a computerized format. How disabled individuals will be afforded fair and equitable access to such testing environments is an issue that will require careful consideration.

Advanced Computer Graphics and Blind Users of Computers

Recent advances in the technology of extremely high resolution computer displays could have devastating consequences for computer users who are blind. The trend in the computer industry is toward the development of highly graphic program designs that make extensive use of the enhanced display capabilities of advanced computer systems. Such systems often replace text-oriented program menus and options with graphic symbols called *icons*. An icon shaped like a computer printer might represent the option to print a document, a tiny trashcan the option to erase a program, a small wristwatch the "please wait" prompt. For a sighted user struggling with the sometimes cryptic commands used by various programs, such graphically oriented systems can be helpful. For a blind user of the computer, such graphically oriented systems represent an enormous barrier. Presently, only one commercially available program exists for reading screens in the Macintosh environment. For graphically oriented, icon-based PC environments, no screen-reading software is currently available. Making graphically oriented computer systems fully accessible to blind users represents an immediate and critical challenge to computer manufacturers and programmers alike.

Since the trend in the computer industry is clearly toward the development of graphically oriented, icon-based systems, blind users are facing the devastating possibility of being denied access to a whole new generation of advanced computer technology. To prevent such disasters, col-

leges and the computer industry must be aware of the access requirements of blind users of computers. If high-resolution, graphically oriented computer systems are the wave of the future — and there are many indications that this is indeed the case — an industry-wide standard must be developed to provide access for nonsighted users.

How do such design oversights occur? Certainly they are not deliberate; in most instances, they are the result of simple benign neglect. As an example, at a recent conference sponsored by the U.S. Department of Education, a major university proudly demonstrated a graphically oriented word-processing system that it had developed and was proposing as the standard word processor to be used by a consortium of colleges and universities from several states. When asked how the developers proposed to provide access to blind students, the college's representative replied, "Gee, I guess we didn't think of that." This is an all-too-common refrain that only an increased public awareness and a persistent demand for equal access will begin to remove.

Several major computer manufacturers have already begun to monitor the development of new products with the special access needs of the disabled in mind. IBM, Digital Equipment Corporation, and Apple Computer all maintain departments employing specialized staff who oversee new product development with an eye to including product features that will assist the disabled user. In many instances, such design modifications benefit the nondisabled user as well. Apple Computer recently added access systems for low-vision and orthopedically disabled persons to the basic operating system files of Macintosh computers; this is an outstanding example of responsible leadership on the part of computer manufacturers.

Access to Publicly Funded Computer Databases

A vast amount of publicly available information is stored in computerized databases established and maintained by federal dollars. These databases are, in effect, enormous public libraries of an entirely new order. They are the future of information storage and retrieval. Access to these resources will clearly separate the information-rich members of our society from the information-poor. It is vitally important that the computer-access requirements of disabled persons be clearly understood and addressed in order to maintain equal access to this wealth of computerized information.

Since these are indeed public libraries, funded by federal dollars and intended for the use of all citizens, they are subject to the provisions of the Architectural Barriers Removal Act of 1968, which states that access for disabled individuals must be provided to any building maintained through the receipt of federal dollars or to buildings used by organizations receiving federal dollars. The advent of advanced technologies will require a reevaluation of our traditional view of access in light of the creation of federally funded "electronic environments" that can be entered only via computer.

Emerging Technologies and Adapted Computer Access

At least three research areas have begun to produce results that hold enormous potential benefit for disabled users of computers: optical pattern recognition, speech recognition, and direct visual selection.

Optical Pattern Recognition

Optical pattern recognition is a process through which a printed document — for example, a business letter — can be automatically converted to a computerized text file editable by any standard word processor. Unlike previous optical character recognition systems, which recognized only specific font styles, optical pattern recognition systems are able to recognize letters based on their general shapes rather than specific font styles. This ability to generalize recognition makes such systems broadly applicable to a wide range of tasks. For blind, low-vision, and learning disabled individuals, this new technology is very useful. Printed documents can be scanned and converted to an accessible computerized text file. On average, the process requires one to two minutes per page and is generally around 99 percent accurate.

Speech Recognition

Although speech recognition technology has been available for many years, the fundamental limitations in accuracy and reliability of even the best speech recognition systems have rendered such devices impractical for general use by orthopedically disabled, learning disabled, or blind users. The ideal adaptation for such individuals, the mythical "talking typewriter," may finally be on the technological horizon. Such a device would accept spoken input at a normal rate of speech, convert everything it "hears" into a computerized text file, insert punctuation marks, correct

spelling, suggest grammatical alterations, and, if desired, print the document. With the advent of new, very high speed microcomputers capable of performing millions of tasks per second and addressing millions of bytes of internal memory, a computer environment now exists that is capable of supporting the dual requirements of effective speech recognition systems: raw processing power and memory.

Because such a device would be of great interest to the general public, it is well within the realm of possibility that highly reliable, entirely speech-activated word-processing systems will be commercially available at a reasonable price within the next five to seven years. Such systems would revolutionize computer access for orthopedically disabled, learning disabled, low-vision, and blind individuals.

Direct Visual Selection

Work in the area of direct visual selection could be of unprecedented benefit to persons with neuromuscular disorders, or with acquired brain injury resulting in severe orthopedic disability. Individuals who, because of the scope and severity of their disability, are unable to produce intelligible speech and have no gross or fine motor control — individuals who have been virtual prisoners within their own bodies — may soon have access to some extraordinary new technologies. Direct visual selection allows such persons to "type" by simply looking at the letter they wish to select.

There are two major lines of development in the area of direct visual selection. The first involves the use of a keyboard-like device, a specialized video camera, and an infrared reference beam; the second incorporates a system that reads selection data directly from the optical cortex of the brain.

The first system, incorporating a keyboard-like device, a specialized video camera, and a reflector, is a commercially available product. Although it has requirements that make it unusable by many severely orthopedically disabled persons, it points the way toward the development of much more broadly effective devices incorporating the same basic technology. A particular liability of the system is its requirement that the user be able to hold his or her head very still while selecting characters from the keyboard emulator. If the user is able to meet this requirement, the system behaves exactly like the computer's keyboard and can be used with either Macintosh or IBM-compatible computers.

A second line of development takes an entirely different approach and may be much more broadly applicable to the computer-access requirements of the severely orthopedically disabled. Not yet a commercially available product, this system reads the electrical activity of the brain's optical cortex. In use, tiny sensors are placed on the scalp over the optical cortex. The user looks at a keyboard-like device, each "key" of which has a small, bright light that blinks at a different rate. The user simply looks at the key he or she wishes to select. The system reads the blink rate of the light directly from the electrical activity of the optical cortex, identifies the key associated with the blink rate, and sends the correct character to the computer. The system is much more tolerant of head motion and nystagmus (rapid eye motion). Although still experimental and subject to random bursts of electrical brain activity, the system appears to be conceptually sound in technology and hopefully will appear as a commercially available product within the next year or two.

New Legislation

Over the last two years, three significant pieces of federal legislation have been introduced that will have a powerful effect on the future of technology and persons with disabilities. In 1986, Congress reauthorized the Rehabilitation Act of 1973 as amended (Public Law 99-506), adding Section 508 on electronic equipment accessibility, "...to insure that handicapped individuals may use electronic office equipment with or without special peripherals." On August 19, 1988, the president signed into law Public Law 100-407, the Technology-Related Assistance for Individuals with Disabilities Act. The intent of this legislation is to expand the availability of assistive technology for persons with disabilities.

Yet to be passed is the Americans with Disabilities Act (ADA) of 1988, authored by Senator Tom Harkin (Democrat, Iowa), and its companion bill, H.R. 4498, authored by Congressman Tony Coelho (Democrat, California). The ADA guarantees that the employment rights secured for women and minorities under Title VII of the Civil Rights Act, as well as legislation covering communications, transportation, public accommodation, and housing, will be extended to the nation's thirty-seven million individuals with disabilities.

Conclusions

Clearly, these recent legislative actions mark a new level of public awareness concerning the computer-access needs of people with disabilities. In conjunction with the emergence of state-sponsored legislative action to improve computer access for persons with disabilities in Massachusetts, Colorado, California, and Hawaii, these recent federal legislative actions acknowledge the critical need to include people with disabilities as productive members of a technology-using society.

It is not coincidental that these remarkable developments in the area of assistive technologies have begun to occur. The developments are a reflection of our growing awareness that people with disabilities can work, can be successful, and can lead productive, happy lives.

We have reached a critical point in the evolution of technology, a point at which we now have the ability to provide meaningful and effective methods for unleashing the vast intellectual and productive capacities of this country's more than thirty-seven million citizens who have disabilities. As a nation, we must foster and nourish all of our resources, including the untapped resource of the disabled. How wonderful to suddenly discover a wealth of talented, enthusiastic, and committed individuals eager to contribute their skills and abilities to the work force. How fitting that technology, which has brought us to the brink of nuclear and environmental catastrophe, should provide the keys to a bright new future for millions of people with disabilities. How gratifying that we, the professional staff of the nation's community colleges, are actually doing so.

Notes

1. California Postsecondary Education Commission, 1985.
2. Rehabilitation Act of 1973, Section 504, 29 U.S.C., 706 and 794 (1973).
3. California Community Colleges Budget Change Proposal, 1988.
4. P. Berman and M. W. McLaughlin, *Federal Programs Supporting Educational Change*, vol. 8 (Santa Monica, Calif.: RAND Corporation, 1978).
5. M. Norris, "Profile of a High Tech Center Director," in C. Brown, ed., *Computer Access in Higher Education for Students with Disabilities* (1987), 5.1-5.24. (Available from the High Tech Centers for the Disabled, 1109 9th Street, Sacramento, California, 95814.)

6. C. German and C. Soderston, "A Study of Analogy and Person in Computer Documentation" (Paper presented at the USER-bility Symposium at the International Business Machines Corporation, Poughkeepsie, N.Y., July 1984) (ERIC Document Reproduction Service No. ED 265 837).
7. W. V. Haney, *Communications and Interpersonal Relations: Text and Cases* (Illinois: Richard D. Irwin, 1986), 89.
8. The Consortium for the Study of Programs for the Brain Injured in the California Community Colleges, *The ABI Handbook: Serving Students with Acquired Brain Injury in Higher Education* (Sacramento, Calif.: California Community Colleges Chancellor's Office, 1987).
9. Rehabilitation Act of 1973 as amended (Pub. L. 99-506), Section 508, 29 U.S.C. 794d (1986).
10. Southeastern Community College v. Davis, 442 U.S. at 412-13 (1979).
11. Alexander v. Choate, 105 S. Ct. at 718-19 (1985).

Works Consulted

"Guidelines for Identifying California Community College Students with Learning Disabilities" (Sacramento, Calif.: California Community Colleges Chancellor's Office, 1987).

"High Tech Center Training Evaluation" (Sacramento, Calif.: California Community Colleges Chancellor's Office High Tech Center for the Disabled, 1988).

"A Study of the Characteristics of Students with Disabilities in California Community Colleges' High Tech Centers for the Disabled" (Sacramento, Calif.: California Community Colleges Chancellor's Office High Tech Center for the Disabled, 1989).

PART IV: Research Study of the High Tech Centers

The following section is a reprint of a study commissioned by the Chancellor's Office of the California Community Colleges. It gives insight into the characteristics of disabled students at the High Tech Centers and the evidence of effectiveness of the program in meeting those special students' educational needs.

A Study of the Characteristics of Students with Disabilities in the California Community Colleges High Tech Centers for the Disabled

---

Disabled Student Programs and Services (DSP&S)

Chancellor's Office
California Community Colleges

August 1989

A Study of the Characteristics of Students with Disabilities in the California Community Colleges High Tech Centers for the Disabled

Prepared by the Staff of the
California Community Colleges Chancellor's Office
High Tech Center for the Disabled

September 5, 1989

DEDICATION

This study is dedicated to the thousands of students with disabilities who make daily use of the California Community Colleges' High Tech Centers program.

What makes these students extraordinary has nothing to do with disability -- what makes these students extraordinary is their unrelenting insistence on having a fair and equal opportunity to compete and succeed.

We are deeply grateful for having been given the opportunity to contribute to the success of persons with disabilities.

CHAPTER 1: Introduction

California has a long history of providing specialized educational programs for the disabled. As early as 1860, a State supported school for deaf and blind children had been established in San Francisco. Over the next century, an additional 28 special education facilities were established to meet the instructional needs of children with disabilities (California Postsecondary Education Commission, 1985.) Although special services for students with disabilities were available at the kindergarten through twelfth grade levels of the public education system in California, little opportunity existed for disabled students (students with low vision, blindness, learning disability, acquired brain injury, physical disability, developmental disability, hearing loss, or deafness) in the State's systems of public postsecondary education.

Motivated in part by language in the newly enacted Federal Rehabilitation Act which read in part "no otherwise qualified handicapped person, shall, on the basis of handicap, be excluded from participation in, be denied the benefits of, or otherwise be subjected to discrimination under any program or activity that receives or benefits from federal financial assistance" (1973 Federal Rehabilitation Act, Section 504, 1973), the California legislature embarked on a series of landmark reforms designed to enhance

educational opportunities for the disabled in each of the three public segments of higher education (University of California, California State University, and the California Community Colleges.)

In 1976, passage of Assembly Bill 77 (Lanterman, 1976) by the California legislature marked a turning point in the lives of thousands of disabled Californians. This bill authorized development of State funded support services and instruction for students with disabilities in the California Community Colleges. Prior to the bill's passage, the community college system, with a state-wide enrollment on its 106 campuses of nearly one million students, was attended by fewer than five thousand disabled students. Within the past twelve years, the number of disabled students attending California community colleges has grown to nearly fifty thousand (California Community Colleges Budget Change Proposal, 1988.)

Although disabled students are attending California community colleges in ever increasing numbers, their level of academic preparation for higher education is often inadequate (Horn, Shell & Severs, 1986). Whether this is a consequence of limited educational opportunity in the K-12 sector or an artifact of disability on the educational process is an issue which this study will not address. Under the mandate of AB 77, the California Community

Colleges Chancellor's Office has, through its Disabled Students Programs and Services [DSP&S] unit, instituted a number of state-wide programs intended to assist disabled students in the successful completion of their postsecondary education. Among the newest of these programs is the state-wide network of High Tech Centers for the Disabled.

For disabled and non-disabled students alike, access to computers is becoming an increasingly critical factor in the successful completion of higher education. Early in the 1960's when microcomputers first began to appear, they were seen by many educators as the great equalizers - devices which would finally allow disabled students to compete as equals in the classroom. These initial optimistic expectations were never realized. Many disabled students found computer access difficult or impossible.

One of the principle reasons for that difficulty lay in a basic design characteristic of computers. The primary interfaces between people and computers are the screen and keyboard. Students with visual and/or orthopedic disabilities have often found these interfaces partially to totally obstructed depending on the nature and severity of their disabling conditions. Within the last two years, new technologies have emerged which allow many disabled individuals to achieve full and unencumbered access to computer systems. Generally referred to as adapted computer

technology (ACT), these new systems provide alternative methods for viewing the computer screen or using the computer keyboard. Adapted computer technology systems tend to be software-based, highly flexible, able to work with standard, commercial software (WordPerfect, dBASE, Lotus, etc.), function on PC or Apple Macintosh computers, and generally cost less than $100.00 per program.

The High Tech Center for the Disabled of the California Community Colleges Chancellor's Office has been largely responsible for the development and implementation of this new generation of adapted computer technology. Through a $5.5 million grant from the California State Department of Rehabilitation, between October, 1986 and June, 1988, a network of 51 High Tech Centers for the Disabled was established at California community colleges across the State. The intent of the program is to provide low vision, blind, deaf and hard-of-hearing, learning disabled, physically disabled, and brain injured students with training in, and access to, specialized computer access systems which allow them to compete effectively in both the academic and work-place environments.

Although more than five thousand disabled persons will participate in High Tech Center programs this year, very little is known about these students. Why they have enrolled in the program, their demographic characteristics

including the type and frequency of their disabilities, educational history and goals, and general level of satisfaction with services provided by High Tech Centers are all unknown.

Without such information, it is very difficult to modify courses to better suit student educational needs, comply with state guidelines such as AB 1725 regarding recruitment of underrepresented students, provide appropriate counseling and academic support services, apportion resources to meet the needs of various disability groups, and respond effectively to the comments and criticisms of students concerning their level of satisfaction with services provided.

It is anticipated that the availability of such information would have a substantial impact on long-range planning, course development, acquisition of major grants, and stabilization of state funding. In many respects, acquisition of the information obtained through this study may, in the long run, spell the difference between the success or failure of the High Tech Centers program in the California Community College system.

This descriptive study proposes as its research question:

What are the characteristics of the disabled students enrolled in the California Community Colleges High Tech Centers programs?

The characteristics (factors) to be examined include: student demographics, disability type, onset of disability, educational history, educational goals, reason for enrolling in the course, and level of satisfaction.

In order to develop such baseline information, this descriptive study will examine the entire population of disabled students who enrolled in and completed a first semester High Tech Center course (Computer Access 1) between June of 1987 and June of 1988 (n=550.) The 25 colleges included in this study represent rural, suburban, and urban settings.

This study will examine such areas as 1) the relationship between disability type and educational goal, 2) age and gender of students participating in the program, 3) the relationship between ethnicity and disability type, 4) the relationship between ease of computer use and disability type, 5) the relationship between student perception of employability and disability type, 6) the relationship between educational goals and perception of employability, 7) the relationship between gender, disability type and educational goals, as well as a variety of other areas.

Data for this study has been gathered from survey questionnaires obtained from disabled students upon completion of the first semester of a High Tech Centers course. Although these data have been collected regularly since June, 1987, this study represents a first attempt to systematically examine the data in order to develop a profile of disabled students attending High Tech Center courses. It is anticipated that the results of this descriptive study will suggest many new areas of inquiry for future exploratory or experimental research designs dealing with computer access and the academic success of disabled students in postsecondary education.

This study contains four additional chapters. Chapter two explores the literature related to background information regarding the disabled population in the United States, the development of special education services for the disabled in California public education, academic difficulties experienced by persons with disabilities in higher education, and the use of specialized computer systems as a method of allowing students with disabilities to compete and succeed in postsecondary education. Chapter three describes the methodology, instrumentation, statistical procedures, and limitations of the study. Chapter four discusses outcomes of the study, and Chapter five contains conclusions and recommendations for future studies.

CHAPTER 2: REVIEW OF THE LITERATURE

Although much progress has been made over the last decade to bring disabled Americans into the mainstream, this group remains far below the social, educational, and financial mean of the population as a whole (Harris, et al., 1986). Harris (1986) also found that persons with disabilities often have yearly incomes below those of inner-city Blacks. In all instances, the Harris studies have concluded that postsecondary education is a critical factor in meaningful employment of persons with disabilities (Harris, 1986, 1987).

Within the last two decades, both the Federal (Federal Rehabilitation Act (Section 504), 1973) and the California legislatures (Lanterman, 1976) have taken major steps to improve postsecondary educational opportunities for persons with disabilities. The primary thrust of these legislative activities have focused on providing educational opportunity through removal of architectural barriers and the development of special education programs for students with unique instructional requirements.

Although educational opportunities now exist, a review of the literature has shown that disabled students pursuing a degree in postsecondary education often experienced severe academic difficulties due to previous educational disadvantagement and/or the consequential effects of their disabling condition (Horn, Shell & Severs, 1986). Whereas the ultimate effectiveness of

computers as teaching tools appears to remain in question (Bozeman, 1988), there is a growing body of evidence which points to a new and unexpected function for microcomputers.

A number of recent articles examined in the process of this review have documented the importance of access to computers for students with disabilities as an important means of improving the academic performance of such students in postsecondary education (Engen-Wedin, Margolis & Collins, 1987; Saka, 1987).

High Tech Centers for the Disabled are breaking new ground in providing computer access for low vision, blind, deaf and hard of hearing, learning and orthopedically disabled college students (Couch, 1987). With the development of tested technological and instructional models for implementing such programs (Brown, 1986), and the advent of mandated levels of computer access on all computer systems purchased by Federal agencies (Federal Rehabilitation Act (Section 508), 1988), disabled students may soon reap the benefits of access to adapted computer technology.

CHAPTER 3: METHODOLOGY

This descriptive study used data collected from all disabled students in the California community college system who completed a course titled Computer Access 1 between June, 1987 and June, 1988. The data were collected in order to identify the characteristics of students with disabilities participating in the High Tech Centers programs.

The survey instrument was developed under the supervision of Dr. Daryl Mellard of the Institute for Research in Learning Disabilities at the University of Kansas, and Dr. Susan Evans of the School of Education at the University of San Francisco. The instrument was evaluated by the administrative staff of the Disabled Students Programs and Services Unit of the California Community Colleges Chancellor's Office. Students were required to complete and return the survey instrument as part of their course work for Computer Access 1.

Two types of data were collected with this survey instrument, nominal and ordinal. For the most part, the instrument employed open ended Likert scales between 1 and 10 (with polarity randomly shifted between 10 as highest and 10 as lowest) to elicit responses to questions. The Likert scales were not forced choice. The number 11 always represented No Opinion or Don't Know. A total of 555 students were included in this study.

The student characteristics to be examined included:

1. student demographics,
2. disability type,
3. onset of disability,
4. educational history,
5. educational goals,
6. reason for enrolling in the course,
7. level of satisfaction.

The information categories and their variables were operationalized as follows:

1. Student demographics were defined as:
   a. Age: date of birth
   b. Ethnicity: race (Black, Hispanic, White, etc.)
   c. Gender: male, female, or decline to state

2. Disability type was defined as:
   Blind, low-vision, physically disabled, learning disabled, deaf or hard-of-hearing, multiple-disabled, or other.

3. Onset of disability was defined as:
   Student's age when disability began.

4. Educational history was defined as:

The highest grade level completed by the student.

4.1 Previous experience with computers was defined as:

At what grade level the student was first introduced to microcomputers.

4.2 Previous experience with specialized computer access systems was defined as:

The grade level at which the student first began using adapted computer systems.

5. Educational goal was defined as:

Vocational certificate, Associate Degree and transfer to a four-year college, Associate Degree/Vocational, Associate Degree/General Education, transfer courses towards a four year degree without Associate Degree, courses of personal interest, courses related to employment, other, or unknown.

6. Reason for enrolling in the course was defined as:

Counselor referral, personal interest, class prerequisite, increase chances of success in other classes, job requirements, parent or other referral, not sure why, or other reasons.

7. Level of satisfaction was defined as the level of agreement / disagreement (on a scale ranging from 10 to 1) with the following statements:

   7.1 Ease of computer use before training
   7.2 Ease of computer use after training
   7.3 Confidence in ability to use special computer systems
   7.4 Ability of staff to answer computer access questions
   7.5 Ability of staff to select correct computer access systems
   7.6 Confidence in ability of access to special computer systems to assist with graduation from college
   7.7 Effect of disability on opportunities for employment
   7.8 Confidence in ability of staff to meet special learning needs.

Treatment of Data

First Level: Characteristics of the Sample

1. The following measures of central tendency and dispersion were applied to all interval variables: minimum, maximum, mean, standard deviation, frequency, and percentage. Frequency and percent only were applied to all nominal variables.

2. All measures of central tendency and dispersion were displayed in tabular format. Percentage data were additionally displayed as either pie charts or bar graphs where such graphics added clarity.

Note: The number 11 (No Opinion) and . (missing data) were excluded from calculations of mean, standard deviation, minimum, and maximum. These values were displayed as a separate statistic where appropriate.

Second Level: Student Characteristics by Disability Type

1. Frequencies and percentages were calculated by disability type for the variables age, ethnicity, and educational goals. For each disability type, measures of central tendency and dispersion were applied to the following variables: ease of computer use before and after training, confidence in ability to use special computer access systems, ability of staff to select correct computer access systems, and perceived effect of disability on opportunities for employment.

2. All measures of central tendency and dispersion were displayed in tabular format. Percentage data were additionally displayed as either pie charts or bar graphs where such graphics added clarity.

3. Where appropriate, chi square analyses were used to provide additional statistical clarity for the following variables by disability type: ethnicity, educational goals, confidence in ability to use special computer access systems, and effect of disability on opportunities for employment.

Note: The number 11 (No Opinion) and . (missing data) were excluded from calculations of mean, standard deviation, minimum, and maximum. These values were displayed as a separate statistic where appropriate.

Third Level: Student Characteristics by Gender

1. By gender type, measures of central tendency, dispersion, frequencies, percentages, and chi square analyses were applied, as appropriate, to the following variables: type of disability, grade level first introduced to computers, grade level first introduced to computers with access, educational goals, reason for enrolling in the High Tech Center course, ease of computer use before and

after training, ability of staff to select correct computer access systems, confidence in ability of access to special computer systems to assist with graduation from college, and perceived effect of disability on opportunities for employment.

2. All measures of central tendency and dispersion were displayed in tabular format. Percentage data were additionally displayed as either pie charts or bar graphs where such graphics added clarity.

Note: The number 11 (No Opinion) and . (missing data) were excluded from calculations of mean, standard deviation, minimum, and maximum. These values were displayed as a separate statistic where appropriate.

Limitations of the Study

As with all studies of this type, accuracy may have been affected by honesty of student responses, misunderstanding of the question, and missing data. Additionally, at least four other factors may have had an effect on this study:

1. In instances where students required the assistance of an instructor to complete the survey, some student satisfaction answers may have been biased.

2. Reversing the polarity of multiple questions directed at the same issue may have confused some students with learning disabilities and resulted in false or misleading data.

3. The survey instrument did not contain a direct question about gender. Determination of male/female was made by examining the first name of the student completing the survey. In some instances, errors may have occurred in this process when examining non gender specific names (i.e. Bobby, Lee, Leslie.)

4. No specific disability category was provided for students with acquired brain injury or developmental disability. These students are grouped in a disability category called "other."

Finally, it is important to note that the survey instrument employed for this study was designed to gather data for a variety of additional studies. Only 18 of the more than 50 questions contained in the instrument were examined by this study.

CHAPTER 4: RESULTS

FIRST LEVEL DATA ANALYSIS: GENERAL CHARACTERISTICS OF STUDENTS IN THE SAMPLE

Student Demographics

For the sample of 527 cases (N = 527), thirty-four percent (34%) of students participating in the High Tech Center programs were between 18 and 24 years of age, twenty-eight percent (28%) were between 25 and 34, seventeen percent (17%) were between 35 and 44, eleven percent (11%) were between 45 and 54, and five percent (5%) were 55 or older. Five percent (5%) of participants did not report their age. The mean age of participants was thirty-two (32) years with a standard deviation of 12.22, a minimum of 19 years of age and a maximum of 89. (See Figure 1.)

The ethnic distribution of students in the sample (N = 555) showed the following results: two percent (2%) of High Tech Center participants were American Indian, nine percent (9%) were Black, four percent (4%) were Asian, thirteen percent (13%) were Hispanic, slightly less than one percent (.72%) were Philippine American, slightly less than one percent (.90%) were Other, Non-Caucasian, and sixty-seven percent (67%) were Caucasian. Three percent (3%) of participants did not report their ethnicity. (See Figure 2.)

In regard to gender for the sample (N = 555), twenty percent (20%) did not provide a first name thus making gender identification impossible. Of those who did provide first names

Figure 1: Age of Participants.

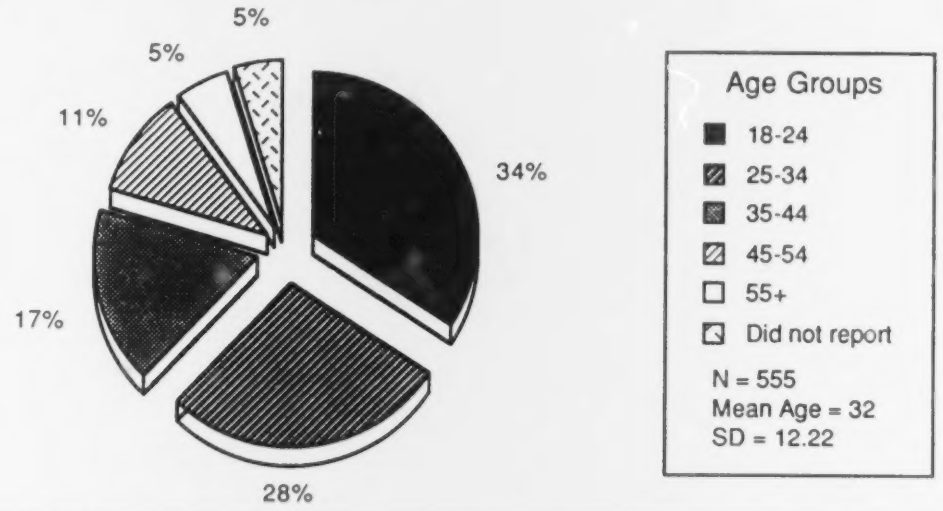
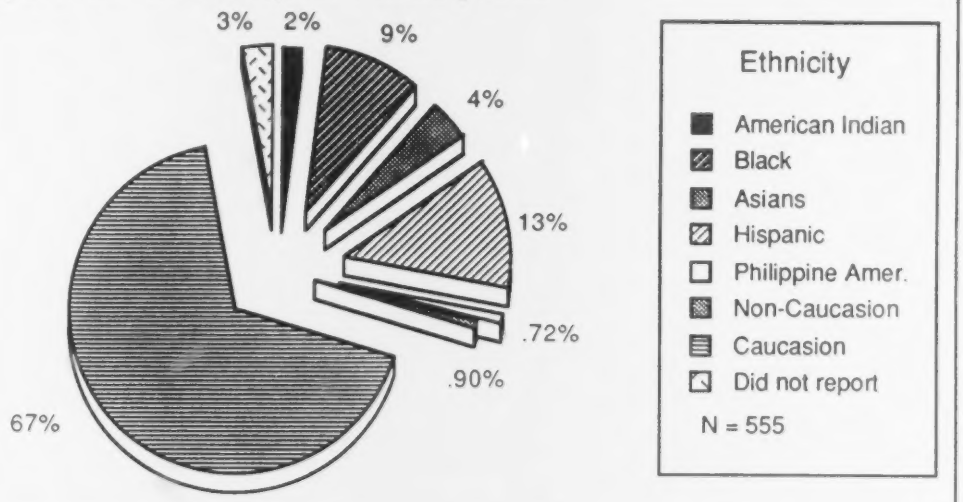


Figure 2: Ethnicity of Participants



from which a determination of gender could be made, forty-two percent (42%) were found to be male and thirty-eight percent (38%) female.

Disability Type

For the sample (N = 555), participants reported their disabilities as five percent (5%) low vision, three percent (3%) blind, thirty-seven percent (37%) learning disability, twenty-three percent (23%) physical disability, two percent (2%) hearing loss, slightly less than one percent (.90%) deaf, seven percent (7%) other disabilities, and twenty percent (20%) multiple disabilities. Two and one-half percent (2.5%) of participants did not report their disability. (See Figure 3.)

Onset of Disability

Data collected regarding age at onset of disability for students in the sample (N = 555) showed that nearly seventy-two percent (71.53%) of all disabling conditions occurred prior to age eighteen (18), eleven percent (11.17%) occurred between 18 and 24 years of age, seven percent (7.21%) occurred between ages 25 and 34, five percent (5.05%) between 35 and 44, three percent (3.24%) between 45 and 54, and nearly two percent (1.80%) after age 55. The mean age at which disability occurred was 11.55 years with a standard deviation of 14.93, a minimum of 0 (birth) and a maximum of 70 years of age. (See Figure 4.)

Figure 3: Participants Disability Type

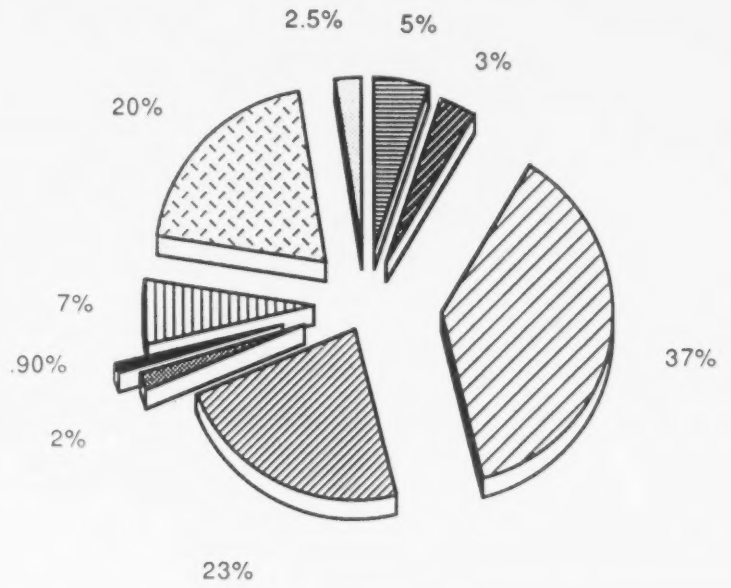


Figure 4: Age at Onset of Disability.

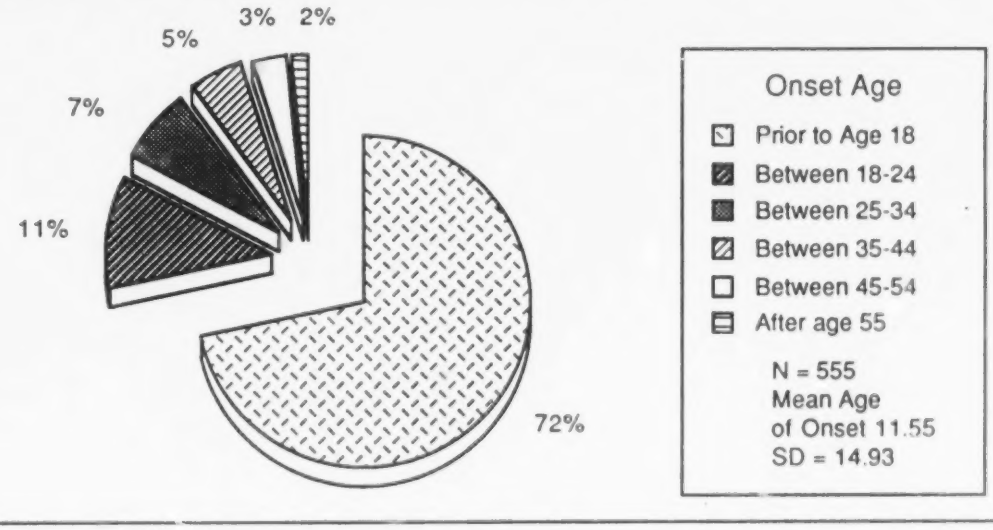
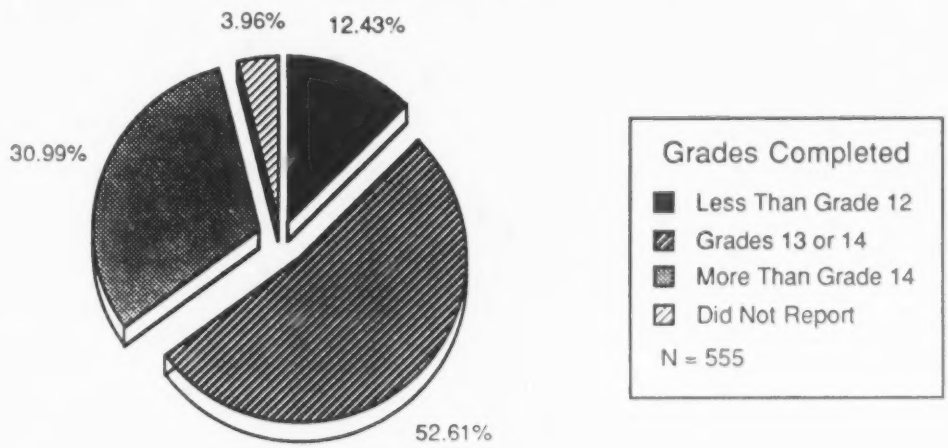


Figure 5: Highest Grade Level Completed by Participants.



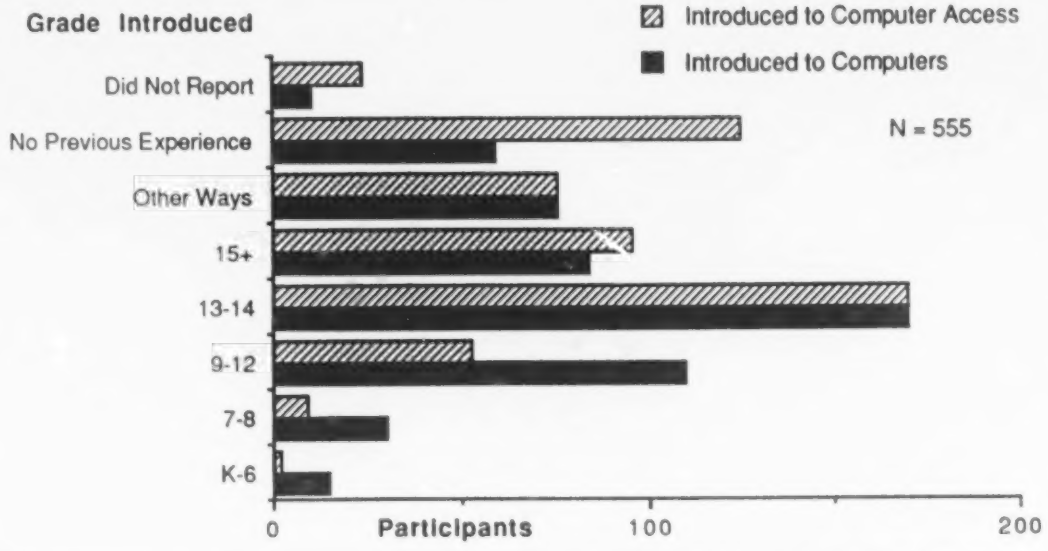
Educational History

This sample of students participating in the High Tech Centers program (N = 555) reported their highest grade levels completed as follows: approximately twelve percent of students (12.43%) had completed less than grade 12, fifty-two percent (52.61%) had completed grades 13 or 14, and thirty-one percent (33.99%) had completed more than grade 14. Twenty-two percent (22%) did not report highest grade completed. (See Figure 5.)

In regard to when they were first introduced to computers, approximately three percent (2.70%) of students indicated between kindergarten and grade 6, five percent (5.41%) between grades 7 and 8, twenty percent (19.82%) between grades 9 and 12, thirty-one percent (30.63%) between grades 13 and 14, and fifteen percent (15.14%) after grade 14. Additionally, fourteen percent (13.69%) had been introduced to computers in other ways, eleven percent (10.63%) had no previous computer experience, and two percent (1.80%) did not respond.

For the sample of students in this study (N = 555), students' responses to when they were first introduced to computer access systems were as follows: less than one percent (.36%) between kindergarten and grade 6, two percent (1.62%) between grades 7 and 8, ten percent (9.55%) between grades 9 and 12, thirty-one percent (30.63%) between grades 13 and 14, and seventeen percent (17.30%) after grade 14. An additional fourteen percent (13.69%) were introduced to computer access systems in other ways, twenty-

Figure 6/7: Grade Level First Introduced to Computers & Computer Access.



three percent (22.52%) had no previous exposure to computer access systems, and four percent (4.32%) failed to report. (See Figures 6 and 7.)

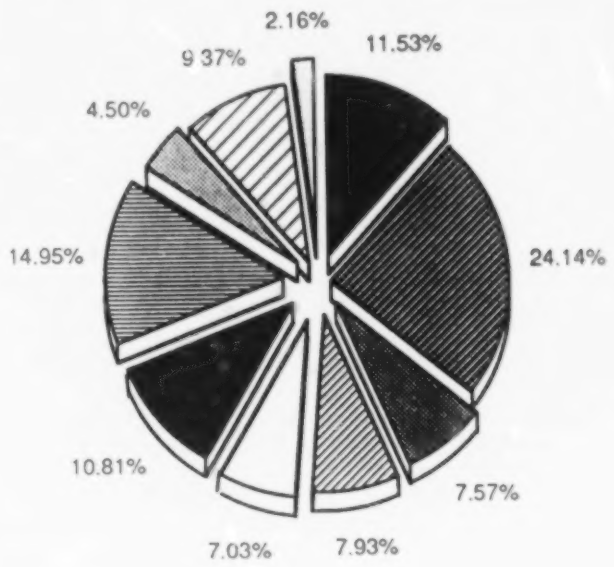
Educational Goal

Students in this study (N = 555) reported their educational goals as follows:

- o Vocational certificate..... 11.53%
- o Vocational Degree + transfer towards a four year degree..... 24.14%
- o Associate Degree/Vocational..... 7.57%
- o Associate Degree/General Ed..... 7.93%
- o Transfer courses toward a four year degree without Associate Degree..... 7.03%
- o Courses of personal interest..... 10.81%
- o Courses related to employment..... 14.95%
- o Other..... 4.5%
- o Unknown..... 9.37%
- o Missing data..... 2.16%

These data indicate that approximately twenty-seven percent (27%) of disabled students sampled have as their educational goal an Associate degree or Vocational certificate, thirty-one percent (31%) of students plan on transfer to a four-year college, nearly fifteen percent (15%) are taking courses related to employment, and the remaining thirteen percent (13%) are taking courses for other or unknown reasons. The data suggest that forty-two percent (42%) of disabled students are on educational tracks leading to employment in two years or less, thirty-one percent (31%) intend to transfer, and twenty-seven percent (27%) have educational goals not specifically related to either transfer or employment. (See Figure 8.)

Figure 8: Educational Goals



- Vocational Certificate
- Vocational Degree + Transfer
- Associate Degree/Vocational
- Associate Degree/General Ed.
- Transfer w/o Associate Degree
- Courses of Personal Interest
- Courses Related to Employment
- Other
- Unknown
- Missing Data

Figure 9: Educational goals by ethnicity.

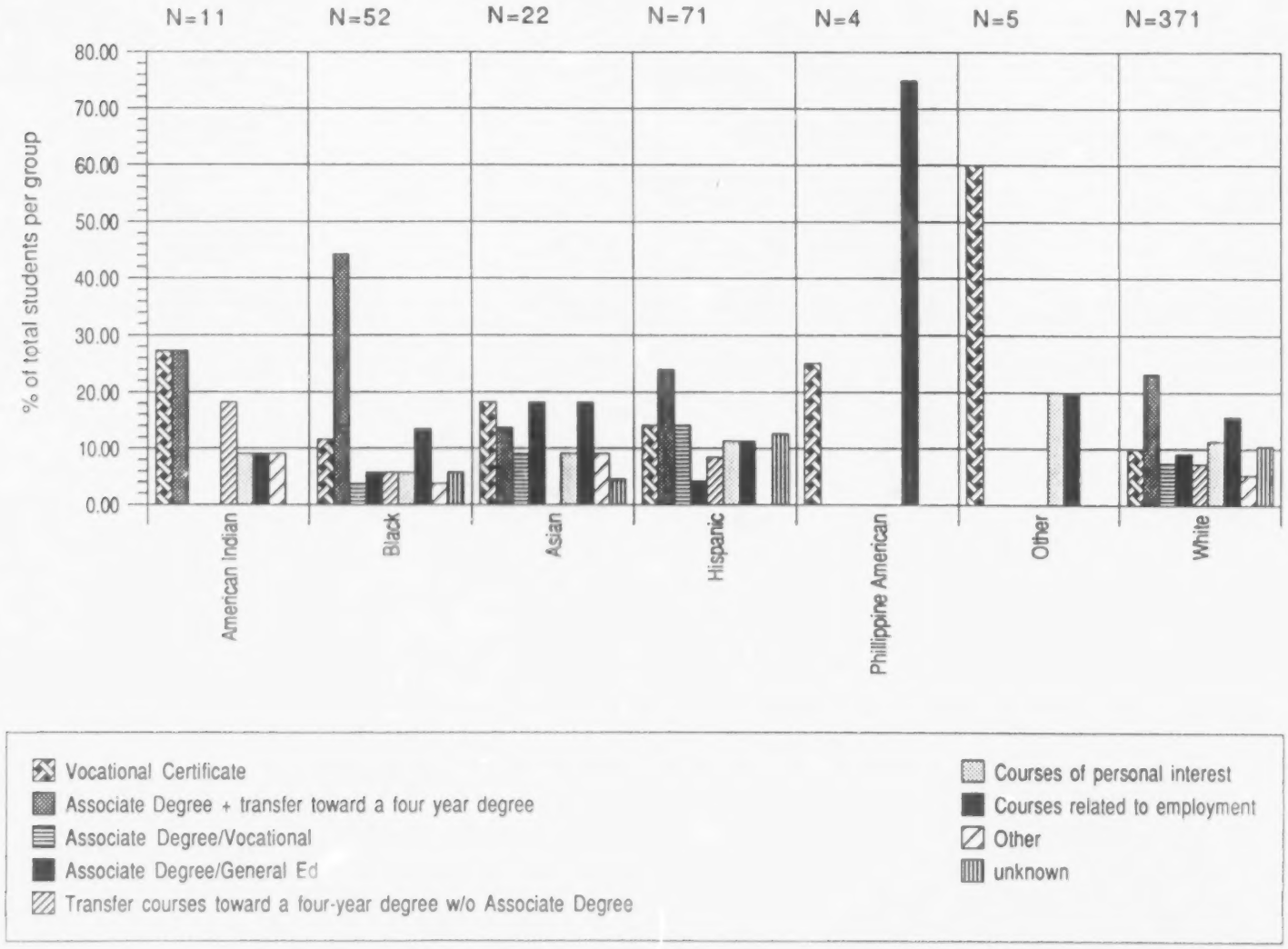


Figure 9 provides an overview of Educational Goal by Ethnicity. Although the limited number of students in some ethnic groupings (American Indian (N=11), Philippine American (N=4), and Other (N=5)) display results which are suspect due to their small sample size, some data are consistent across most other ethnic groups. Associate Degree + transfer toward a four year degree is the leading education goal, followed by courses related to employment, and Vocational Certificate. The data indicate that disabled Black students choose the goal of Associate Degree + transfer toward a four year degree more frequently than all other ethnic groups in this study.

Reason for Enrolling

For the sample of students in this study (N = 555), their reasons for enrolling in the High Tech Centers course were reported as follows:

- Required before I can enroll in another class I want to take..... .90%
- To increase my chances of success in other classes..... 28.11%
- Counselor recommended I enroll in the course..... 11.17%
- For job requirements/need..... 12.79%
- For personal interest..... 17.12%
- Parent or other encouraged me to enroll..... 1.98%
- Not sure why..... 1.44%
- Other..... 5.41%
- Multiple reasons..... 17.84%
- Missing data..... 3.24%

Analysis of these data reveal that approximately thirty-nine percent (39%) of students enrolled in High Tech Center courses

for academically related reasons, thirteen percent (13%) for employment related reasons, and forty-four percent (44%) for personal, multiple, or other reasons.

Level of Satisfaction

On a scale of 10 to 1, with 10 as "difficult" and 1 "easy," students reported ease of computer use before High Tech Center training as follows:

1	(Easy)	6.85%
2		2.70%
3		3.96%
4		4.68%
5		9.55%
6		7.39%
7		6.49%
8		7.93%
9		7.75%
10	(Difficult)	28.47%
11	(Don't Know)	10.27%
	Missing data	3.90%

N of cases = 477
Mean = 6.99
SD = 3.02

More than fifty-eight percent (58%) of students responding reported that computer use before High Tech Center training was moderately difficult to difficult. An additional twenty-eight (28%) percent reported computer use as moderately easy to easy. Ten percent (10%) of students didn't know and a final four percent (4%) did not respond.

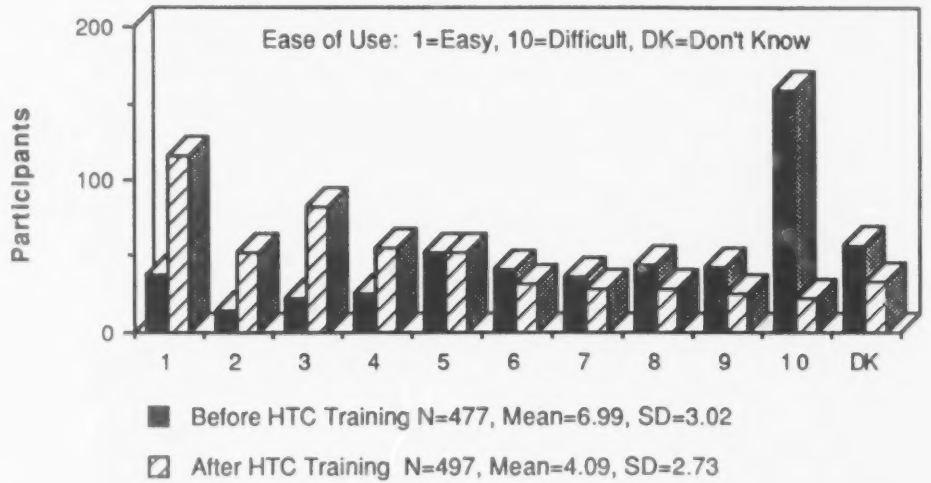
On a scale of 10 to 1, with 10 "difficult" and 1 "easy," students reported ease of computer use after High Tech Center training as follows:

1	(Easy)	20.98%
2		9.55%
3		14.77%
4		10.09%
5		9.37%
6		5.77%
7		5.32%
8		5.05%
9		4.68%
10	(Difficult)	4.14%
11	(Don't Know)	6.13%
	Missing data	4.32%

N of cases = 497
Mean = 4.09
SD = 2.73

After completion of High Tech Center training, nearly sixty-five percent (64.76%) of students reported that computer use was now moderately easy to easy. Approximately twenty-five percent (24.96%) of students reported that computer use remained moderately difficult to difficult. An additional six percent (6%) didn't know and four percent (4%) did not respond. It is significant to note that the mean dropped from a pre-training high of 6.99 to a post-training low of 4.09. The pre (3.02) and post-training (2.73) standard deviation values suggest that all participants generally were able to improve ease of computer use equally. (See Figure 10.)

Figure 10: Ease of Computer Use Before and After High Tech Center Training



On a scale of 10 to 1, with 10 as "strongly agree" and 1 "strongly disagree," students responded to the statement that <u>they felt confident in their ability to use adapted computer technologies</u> as follows:

1	(Strongly disagree)	1.26%
2		1.62%
3		1.08%
4		1.80%
5		7.93%
6		5.59%
7		7.21%
8		11.35%
9		8.47%
10	(Strongly agree)	42.16%
11	(Don't Know)	7.39%
	Missing data	4.14%

N of cases = 491
Mean = 8.22
SD = 2.25

Nearly fifty-one percent (51%) of students were very confident in their ability to use assistive technologies, nineteen percent (19%) were moderately confident, thirteen percent (13%) were neutral, three percent (3%) had only moderate confidence, and three percent (3%) were not confident. An additional seven percent (7%) didn't know, and four percent (4%) did not respond. With a mean of 8.22 and a standard deviation of 2.25, it would appear that students are confident of their ability to use assistive computer technologies.

On a scale of 10 to 1, with 10 as "strongly agree" and 1 "strongly disagree," students reported their responses to the ability of staff to answer computer access questions:

```
 1 (Strongly disagree)..... 1.08%
 2 ..... .18%
 3 ..... .36%
 4 ..... .72%
 5 ..... 4.32%
 6 ..... 2.70%
 7 ..... 4.86%
 8 ..... 3.47%
 9 ..... 12.25%
10 (Strongly agree)..... 57.84%

11 (Don't Know)..... 3.96%
   Missing data..... 3.06%
   N of cases = 516
   Mean = 9.00
   SD = 1.81
```

More than seventy percent (70.09%) of students strongly agreed that their instructors were able to answer questions pertaining to computer access. Thirteen percent (13.33%) of students agreed, seven percent (7.02%) were neutral, one percent (1.08%) moderately disagreed, and one percent (1.18%) strongly disagreed. An additional four percent of students (3.96%) didn't know, and three percent (3.06%) did not respond. Again, with a mean of 9.00 and a standard deviation of 1.81, it would appear that instructors are well able to answer student's questions regarding assistive computer technology.

On a scale of 10 to 1, with 10 as "strongly agree" and 1 "strongly disagree," students reported their responses to the ability of staff to select computer access systems appropriate to student needs.

1	(Strongly disagree)	1.44%
2		0.00%
3		.36%
4		1.44%
5		5.41%
6		3.24%
7		6.85%
8		8.83%
9		9.19%
10	(Strongly agree)	50.09%
11	(Don't Know)	8.47%
	Missing data	4.68%

N of cases = 482
Mean = 8.71
SD = 1.97

The majority of students, (59.28%), strongly agreed that instructors were able to select computer access systems appropriate to their needs. Sixteen percent (15.68%) agreed, nine percent (8.65%) were neutral, two percent (1.80%) moderately disagreed, and one percent (1.44) strongly disagreed. Eight percent (8.47%) of students didn't know, and five percent (4.68%) did not respond. The mean of 8.71 and standard deviation of 1.97 suggest that instructors have been quite successful at meeting the computer access needs of students.

On a scale of 10 to 1, with 10 as "strongly agree" and 1 "strongly disagree," students reported their responses to the importance of computer access in assisting with graduation from college.

1	(Strongly disagree)	7.39%
2		1.26%
3		2.88%
4		2.52%
5		6.67%
6		6.13%
7		7.57%
8		8.11%
9		9.01%
10	(Strongly agree)	30.45%
11	(Don't Know)	12.97%
	Missing data	5.05%

N of cases = 455
Mean = 7.34
SD = 2.94

Analysis of this data reveals somewhat more variation. Thirty-nine percent (39.46%) of students strongly agree that computer access is important for graduation from college. Sixteen percent (15.68%) agree, thirteen percent (12.80%) are neutral, five percent (5.40%) moderately disagree, and nine percent (8.60%) strongly disagree. Thirteen percent (12.97%) of students don't know, and five percent (5.05%) did not respond. These data may reflect the relatively high percentage of vocationally oriented students in the sample, orientation towards majors which do not require the use of technology, or simply inexperience with the academic requirements of postsecondary education. (See Figure 11.)

On a scale of 10 to 1, with 10 as "strongly agree" and 1 "strongly disagree," students reported their responses to the statement that their disability would have an effect on their opportunities for employment.

1	(Strongly disagree)	14.23%
2		4.14%
3		5.41%
4		4.14%
5		10.27%
6		7.93%
7		7.03%
8		7.93%
9		6.85%
10	(Strongly agree)	20.90%
11	(Don't Know)	8.11%
	Missing data	3.06%

N of cases = 493
Mean = 6.05
SD = 3.24

Examination of this data reveals considerable variation. Nearly twenty-eight percent (27.75%) of students strongly agree that their disability will affect opportunities for employment. Fifteen percent (14.96%) of students agree, eighteen percent (18.20%) are neutral, ten percent (9.55%) disagree, and eighteen percent (18.37%) strongly disagree. An additional eight percent (8.11%) of students didn't know, and three percent did not respond. With a mean of 6.05, it would appear that students are uncertain about what the impact of their disability on employment will be. It is important to note, however, that forty-three percent of students appear to believe that it will have a moderate to significant effect. The large standard deviation (3.24) also suggests wide variability of belief. It is likely

that this range of beliefs reflects the differing outlooks of students with differing disabilities, ages, and occupational goals. (See Figure 12.)

On a scale of 10 to 1, with 10 as "strongly agree" and 1 "strongly disagree," students reported their responses to the ability of instructional staff to meet their special learning needs.

1	(Strongly disagree)	.54%
2		.18%
3		.36%
4		.90%
5		3.78%
6		3.06%
7		8.29%
8		8.65%
9		10.27%
10	(Strongly agree)	58.74%
11	(Don't Know)	2.34%
	Missing data	2.88%

N of cases = 526
Mean = 8.96
SD = 1.68

The majority of students (69.01%) strongly agreed that instructors were able to meet their special learning needs. Seventeen percent (16.94%) agreed, seven percent (6.84%) were neutral, one percent (1.26%) disagreed, and less than one percent (.72%) strongly disagreed. An additional two percent (2.34%) of students didn't know, and three percent (2.88%) did not respond. The mean of 8.96 and standard deviation of 1.68 suggest that students are well satisfied with the ability of instructors to meet their special learning needs.

Figure 12: Responses to the statement that their disability would have an effect on their opportunities for employment.

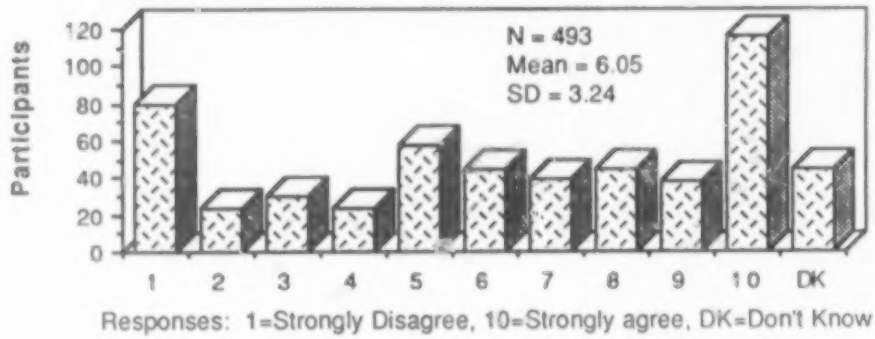
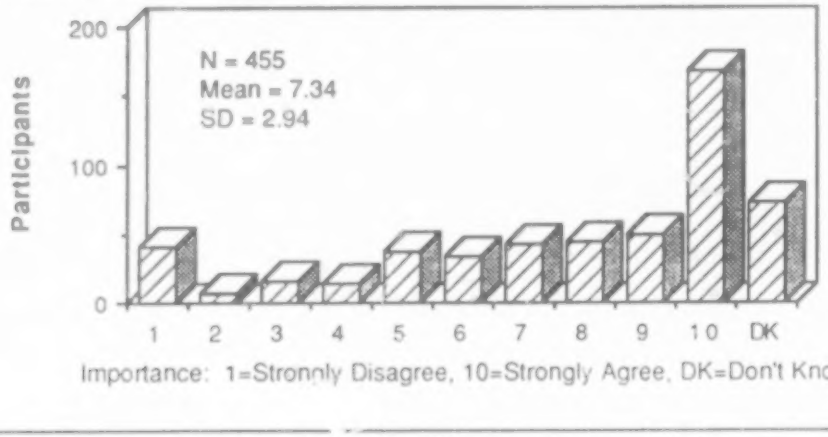


Figure 11: Student's belief in the Importance of Computer Access to Graduation from College.



SECOND LEVEL DATA ANALYSIS:
STUDENT CHARACTERISTICS BY DISABILITY TYPE

Table 1

Age by Disability Type Expressed as Percentages

Disability	N	Mean	SD	Years of Age <18 %	18-24 %	25-34 %	35-44 %	45-54 %	>54 %
Low Vision	29	2.86	1.18	6.90	41.38	24.14	13.79	13.79	0.0
Blind	18	3.61	1.09	0.0	16.67	27.78	38.89	11.11	5.56
LD	208	2.85	1.05	2.88	43.75	28.85	15.38	8.17	.96
Physical	126	3.22	1.20	2.38	28.57	34.92	19.05	8.73	6.35
Deaf	10	3.30	1.56	0.0	50.00	10.00	10.00	10.00	10.00
Hard of Hearing	5	2.20	0.44	0.0	80.00	20.00	0.0	0.0	0.0
Other	34	3.50	1.44	2.94	23.53	32.35	20.59	2.94	17.65
Multiple	111	3.54	1.41	4.50	24.32	23.42	18.02	19.82	9.91

Note: Age ranges were grouped into six categories ranked between 1 and 6 with category 1 representing < 18 years of age and category 6 > 54 years of age. Values for Mean and SD were derived from those categories.

These data suggest that the majority of students in all disability groups cluster most heavily between the ages of eighteen (18) and thirty-four (34) years of age. There are several anomalies to this grouping which require mention. Nearly sixty-seven percent (66.67%) of all blind students were between the ages of twenty-five (25) and forty-four (44). The largest single cluster, (43.75%), of students with learning disabilities is between eighteen (18) and twenty-four (24) years of age. The largest single cluster, (41.38%), of low vision students is also between eighteen (18) and twenty-four (24) years of age.

Table 2

Disability by Ethnicity

This table examines the distribution of disability types by ethnicity. The ethnic category "Alaskan Native" was included under Pacific Islander to facilitate statistical analysis. (See Figure 13.)

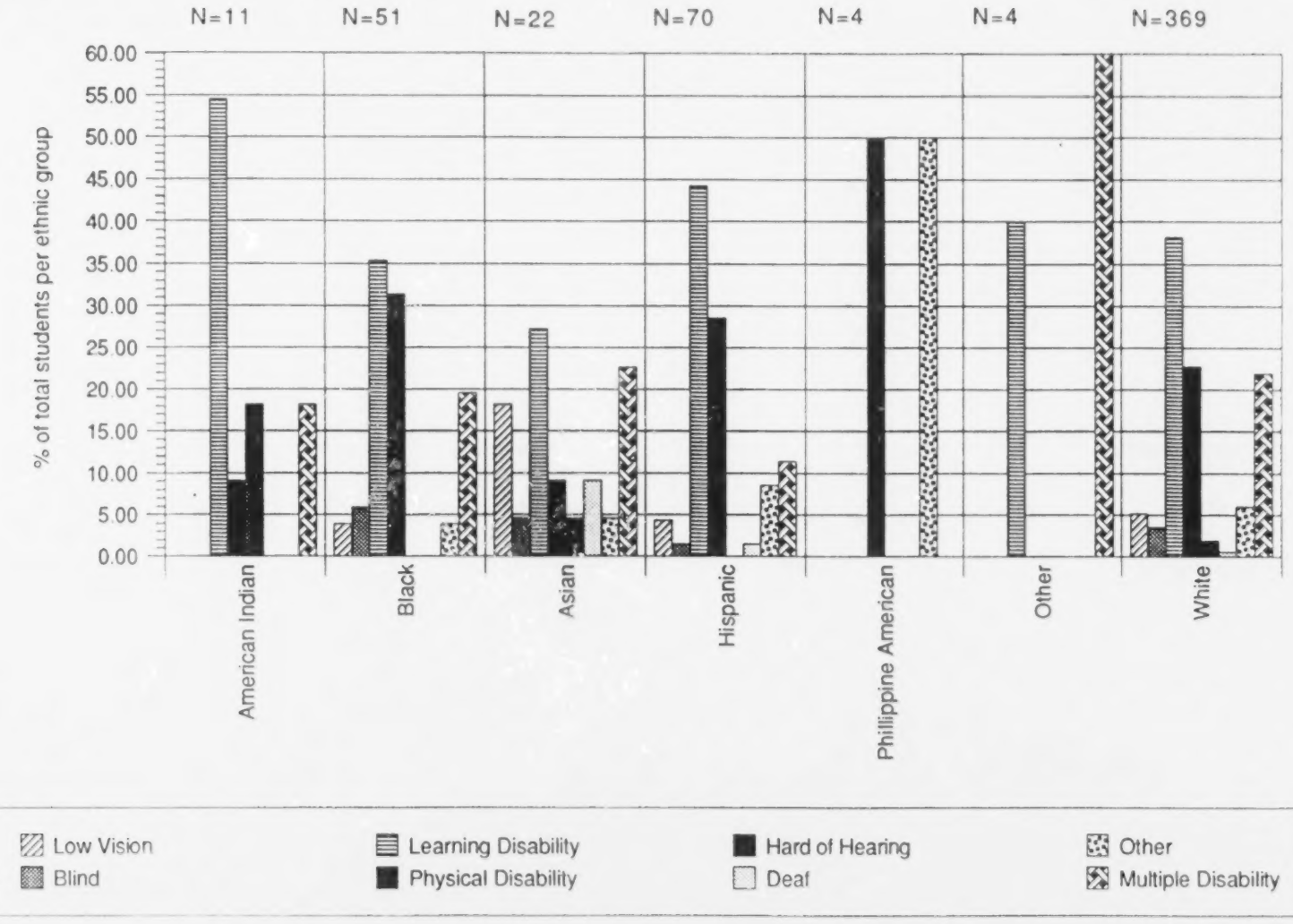
		Disability							
Ethnicity	N	LV	B	LD	PD	HH	D	O	M
		%	%	%	%	%	%	%	%
A	11	0.0	0.0	54.55	9.09	18.18	0.0	0.0	18.18
B	51	3.92	5.88	35.29	31.37	0.0	0.0	3.92	19.61
C	22	18.18	4.55	27.27	9.09	4.55	9.09	4.55	22.73
D	0	-.-	-.-	-.-	-.-	-.-	-.-	-.-	-.-
E	70	4.29	1.43	44.29	28.57	0.0	1.43	8.57	11.43
F	4	0.0	0.0	0.0	50.00	0.0	0.0	50.00	0.0
G	4	0.0	0.0	40.00	0.0	0.0	0.0	0.0	60.00
H	369	5.15	3.52	38.21	22.76	1.90	.54	5.96	21.95

IDENTIFICATION KEY

A = American Indian
B = Black (non-Hispanic)
C = Asian
D = Pacific Islander
E = Hispanic
F = Philippine American
G = Other
H = White

To further evaluate the data regarding ethnicity, ethnicity was crosstabulated by educational goals. Before the x^2 analysis could be performed, modifications were performed to transform both data sets due to small cell frequencies. The resulting 4 X 6 crosstabulation includes 4 ethnic groups: Black, Hispanic, Caucasian, and Asian/Other and 6 educational goals: vocational certificate, transfer to a four year degree program, associate

Figure 13: Disability types across ethnicity



degree - vocational, associate degree - general education, employment related and personal interest/other.

Because of small cell sizes, the American Indian, Asian, Philippine American, and Other Non-White [ONW] students were collapsed into one ethnic group for the purposes of this study. The calculated x^2 and p values for this crosstabulation were significant ($x^2 = 29.03$; df = 15; $p \leq .016$).

Crosstabulation Table A

x^2 crosstab of ethnic group by educational goals (observed frequencies). N = 536

	Voc	Trans	AA/Voc	AA/GE	Employ	Other	
Asian/ Other	11	8	2	4	9	8	42
B	6	26	2	3	7	8	49
H	10	23	10	3	8	17	71
C	37	113	28	34	58	101	371
	64	170	42	44	82	134	

The results of this x^2 suggest that the educational goals of Hispanic students tends to be vocational training rather than further higher education or employment related. There are also a disproportionate number of Caucasian students enrolled in courses to pursue personal interests or for other reasons than job training or the attainment of a degree. Black students appear most interested in transferring to a four year degree program.

Table 3

Educational Goals by Disability Type

This table examines the educational goals of students by disability type. In this table, low vision and blind were collapsed into a single category to facilitate statistical analysis.

	Educational Goal								
Disability	A	B	C	D	E	F	G	H	I
	%	%	%	%	%	%	%	%	%
LV or Blind	13.04	19.57	13.04	6.52	10.87	4.35	19.57	8.70	4.35
LD	16.02	28.16	7.28	11.17	7.77	8.74	7.28	2.43	11.17
Physical	7.94	23.81	7.94	5.56	8.73	13.49	23.02	2.38	7.14
Deaf or HH	6.67	20.00	6.67	20.00	0.00	6.67	6.67	6.67	26.67
Other	6.06	21.21	6.06	3.03	6.06	21.21	21.21	9.09	6.06
Multiple	9.01	24.32	7.21	6.31	4.50	12.61	18.92	8.11	9.01

IDENTIFICATION KEYS

A = Vocational certificate
B = Vocational Degree + transfer towards a four year degree
C = Associate Degree/Vocational
D = Associate Degree/General Ed
E = Transfer courses toward a four year degree without Associate Degree
F = Courses of personal interest
G = Courses related to employment
H = Other
I = Unknown

To further evaluate the data regarding educational goals and disability types, educational goal was crosstabulated with type of disability. Before the x^2 analysis could be performed, modifications were performed to transform both data sets due to small cell frequencies. The resulting 5 X 6 crosstabulation includes 5 disability types LD, Physical, Multiple, LV/Blind, and Hearing and 6 educational goals: vocational certificate, transfer to a four year degree program, associate degree - vocational,

associate degree - general education, employment related and personal interest/other.

Again, the small number of students in the Hearing Impaired (HI) group resulted in unavoidable violations of the assumptions which underlie x^2 analysis but only for this disability group. It is therefore with caution that the calculated x^2 and p values for this crosstabulation be viewed ($x^2 = 29.754$; $df = 20$; $p \leq .07$).

Crosstabulation Table B

x^2 crosstab of educational goals by disability groups (observed frequencies). N = 537

	Voc	Trns	AA/Voc	AA/GE	Employ	Other	
LV/Blind	6	14	6	3	9	8	46
LD	35	83	17	24	22	58	239
Physical	10	41	10	7	29	29	126
Hearing	1	3	1	3	1	6	15
Multiple	10	32	8	7	21	33	111
	62	173	42	44	82	134	

It appears that most of the students, regardless of disability group, had the same three goals: transfer to a four year degree program, vocational training, or ongoing job training. Due to the small N, no conclusions can be drawn for the HI group. Many of these respondents in all disability groups had no specific educational goal other than personal interest.

Table 4

Ease of Computer Use Before and After HTC Training by Disability Type

	Easy								Difficult	
	1	2	3	4	5	6	7	8	9	10
DISAB.	%	%	%	%	%	%	%	%	%	%
LV	7.69	0.0	0.0	0.0	7.69	3.85	0.0	7.69	23.08	46.15
	18.52	14.81	22.22	7.41	18.52	0.0	3.70	3.70	3.70	7.41
Blind	13.33	0.0	0.0	6.67	0.0	6.67	13.33	13.33	6.67	40.00
	35.29	0.0	23.53	5.88	11.76	0.0	5.88	5.88	11.76	0.0
LD	7.03	3.24	3.78	6.49	15.14	7.03	7.57	9.19	11.35	28.65
	21.05	13.16	13.68	13.16	8.42	8.95	6.32	5.79	4.21	5.26
Physical	8.41	2.80	6.54	7.48	12.15	14.02	4.67	9.35	4.67	29.91
	28.07	11.40	19.30	6.14	14.04	3.51	2.63	7.89	6.14	.88
Deaf	14.29	0.0	14.29	0.0	0.0	0.0	14.29	14.29	0.0	42.86
	33.33	11.11	33.33	0.0	0.0	0.0	0.0	0.0	11.11	11.11
H of H	0.0	50.00	0.0	0.0	0.0	50.00	0.0	0.0	0.0	0.0
	100.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	6.25	9.38	6.25	3.13	3.13	9.38	18.75	15.63	6.25	21.88
	25.81	3.23	25.81	3.23	3.23	3.23	16.13	3.23	3.23	12.90
Multiple	8.08	2.02	5.05	4.04	9.09	5.05	7.07	7.07	8.08	44.44
	19.23	8.65	12.50	19.23	10.58	7.69	6.73	4.81	5.77	4.81

Note: In each pair, the first row represents ease of computer use before HTC training, the second row represents ease of computer use after HTC training.

	N		Mean		SD	
Low Vision	26	27	8.26	4.00	2.63	2.73
Blind	15	17	7.40	3.82	3.15	2.89
Learning Disabled	185	190	6.93	4.17	3.00	2.72
Physically Disabled	107	114	6.57	3.70	2.99	2.60
Deaf	7	9	7.00	3.66	3.65	3.42
Hard of Hearing	2	2	4.00	1.00	2.82	0.0
Other	32	31	6.59	4.54	2.92	3.21
Multiple Disability	99	104	7.42	4.35	3.05	2.66
	B	A	B	A	B	A

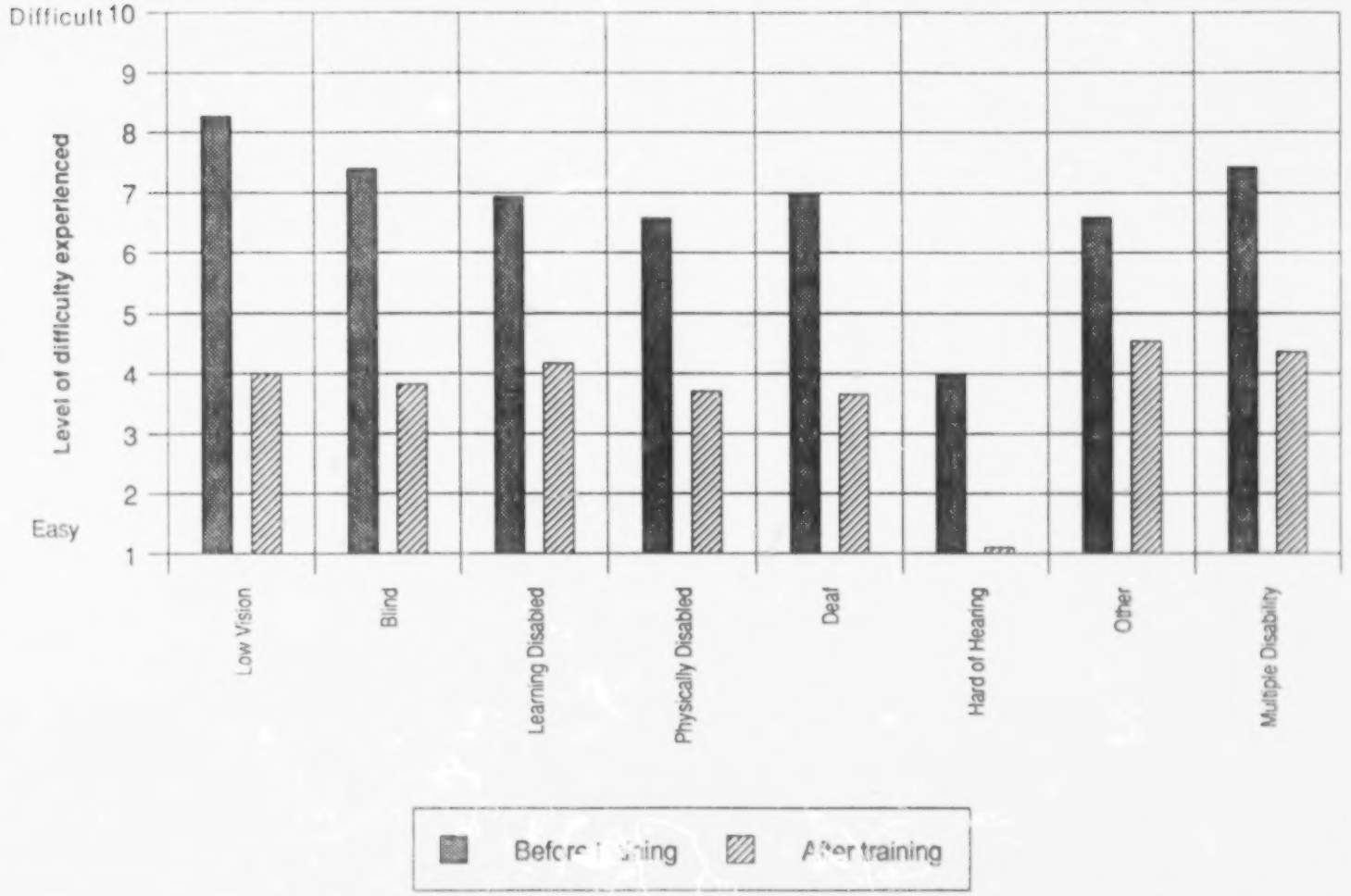
Overall, disabled students reported a forty-six percent (46%) increase in ease of computer use upon completion of High Tech Center training. Highest levels of increase were reported by students with low vision at fifty-two percent (52%). Lowest levels of gain (31%) were reported by students in the Other group. Although the Hard of Hearing group reported dramatic increases (75%) in ease of computer use, caution is advised in interpreting the results of this group due to its small N. (See Figure 14)

Disability Group by Confidence in Ability to Use Special Computer Access Systems

Likert scale response to the statement "I am confident that I will be able to use special computer systems" was crosstabulated with type of disability. Before the x^2 analysis could be performed, modifications were required to transform both data sets due to small cell frequencies. The resulting 5 X 5 crosstabulation includes 5 disability groups: LD, Physical, Other, LV/Blind, and Hearing and a 5 level Likert like scale from 1 (Strongly disagree) to 5 (Strongly agree).

The small number of students in the Hearing group resulted in unavoidable violations of the assumptions which underlie x^2 analysis but only for this disability group. It is, therefore, with caution that the calculated x^2 and p values for this crosstabulation be viewed ($x^2 = 34.128$; $df = 16$; $p \leq .005$).

Figure 14: Ease of computer use before and after High Tech Center training.



Crosstabulation Table C

x^2 crosstab of confidence in ability to use special access systems by disability group (observed frequencies) N = 488.

	(Strongly disagree) 1	2	3	4	5 (Strongly agree)	
LV/Blind	0	1	6	9	30	46
LD	10	7	39	51	106	213
Physical	2	2	14	23	75	116
Hearing	1	3	2	2	5	13
Other	3	1	14	18	64	100
	16	14	75	103	280	

Table 5

Ability of HTC Staff to Select Correct Access Systems by Disability

				Strongly Disagree									Strongly Agree
				1	2	3	4	5	6	7	8	9	10
DISAB.	N	Mean	SD	%	%	%	%	%	%	%	%	%	%
LV	29	9.06	1.87	3.45	0.0	0.0	0.0	0.0	0.0	10.34	10.34	10.34	65.52
Blind	18	8.38	2.66	5.56	0.0	0.0	5.56	5.56	5.56	0.0	11.11	5.56	61.11
LD	179	8.40	2.05	1.12	0.0	1.12	2.23	8.38	5.03	11.73	10.06	10.61	49.72
Physical	109	8.96	1.78	.92	0.0	0.0	0.0	8.26	3.67	5.50	5.50	11.93	64.22
Deaf	7	6.85	3.18	14.29	0.0	0.0	14.29	0.0	0.0	0.0	42.86	14.29	14.29
H of H	3	8.66	2.30	0.0	0.0	0.0	0.0	0.0	33.33	0.0	0.0	0.0	66.67
Other	28	9.28	1.41	0.0	0.0	0.0	0.0	3.57	3.57	7.14	7.14	3.57	75.00
Multiple	104	8.94	1.82	1.92	0.0	0.0	1.92	2.88	1.92	5.77	12.50	12.50	60.58

High levels of confidence in the ability of staff to select correct access systems were expressed by all disability groups except the Deaf. Although this group's confidence was only moderately high, it is interesting to note the large standard

deviation (3.18), perhaps indicating a wide range of opinion among this group's members.

Table 6

Perceived Effect of Disability on Opportunities for Employment

The question of whether disability would have an effect on opportunities for employment was evaluated by type of disability to produce the following table. In this table, a response of ten (10) indicates strong agreement that disability will have an effect on opportunities for employment; a response of one (1) indicates strong disagreement.

	Strongly Disagree							Strongly Agree		
Disab.	1	2	3	4	5	6	7	8	9	10
	%	%	%	%	%	%	%	%	%	%
LV/Blind	10.6	2.13	6.38	4.26	2.64	4.26	10.64	8.51	12.77	25.53
LD	16.67	5.39	7.84	5.88	11.27	7.35	10.78	7.35	5.39	12.25
Physical	16.13	4.84	4.03	4.03	12.90	8.06	4.03	8.06	6.45	23.39
D or HH	13.33	0.0	6.67	6.67	13.33	13.33	6.67	6.67	0.0	20.00
Other	35.29	2.94	2.94	0.0	8.82	8.82	0.0	2.94	2.94	20.59
Multiple	5.45	3.64	3.64	1.82	6.36	10.91	5.45	10.91	10.91	35.45

	N	Mean	SD	11 (Don't Know)
Low Vision or Blind	45	6.71	3.10	4.3%
Learning Disabled	184	5.32	3.08	9.8%
Physically Disabled	114	6.00	3.33	8.1%
Deaf or Hard of Hearing	13	5.84	3.13	13.3%
Other	29	4.72	3.80	14.7%
Multiple Disability	104	7.47	2.83	5.5%

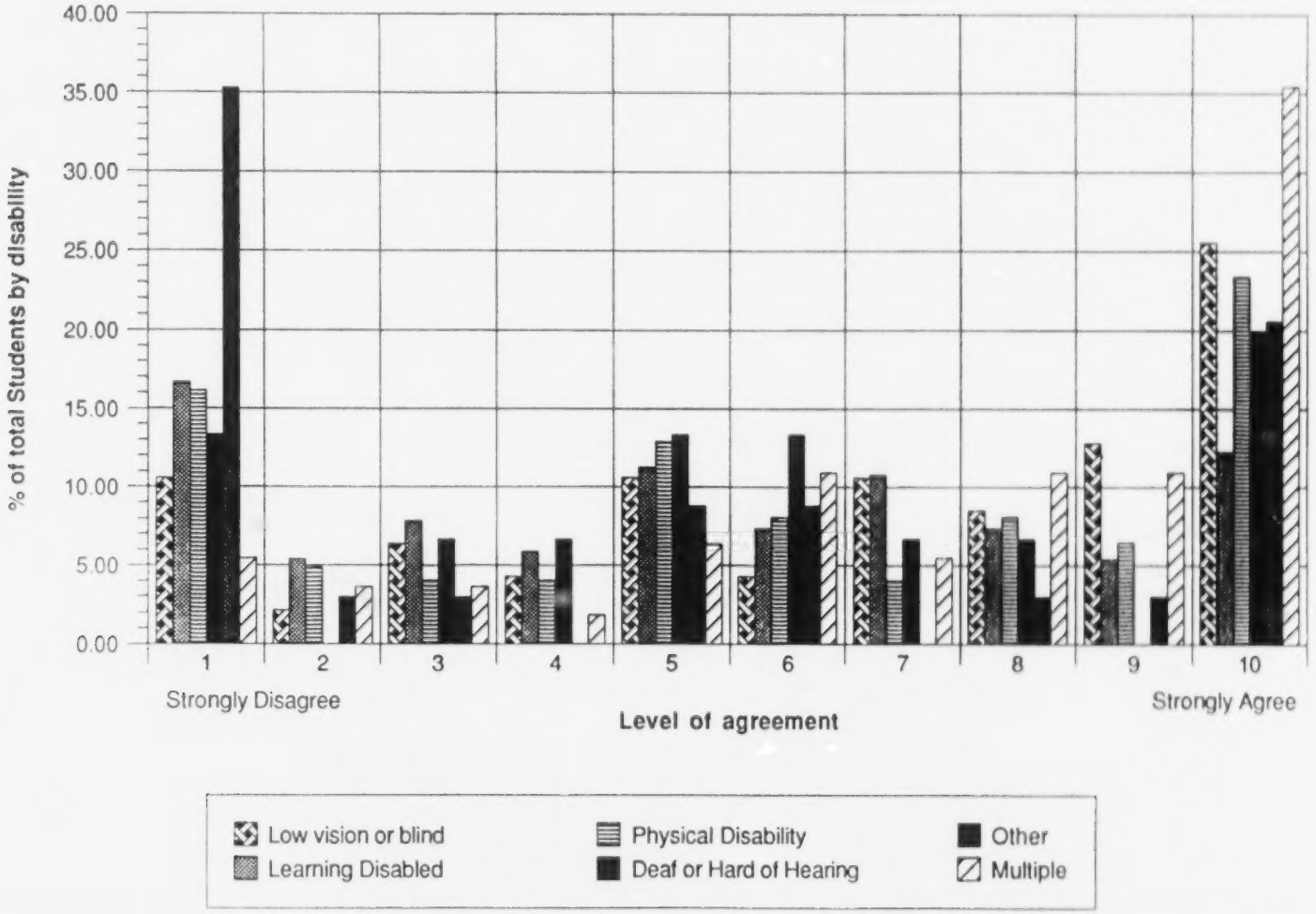
Evaluation of the data reveals that persons with multiple disabilities most strongly and consistently believe that their

disability will affect their opportunities for employment. Persons who are blind or have low vision rank second in the extent to which they believe their disability will affect opportunities for employment followed by persons with physical disabilities, the deaf or hard-of-hearing, learning disabled, and other. The relatively low perceived impact of disability on employment by the "other" group is probably due to the composition of its members. This group typically consists of persons with only moderately debilitating or "invisible" disabilities, i.e, asthma, heart conditions, epilepsy, etc. (See Figure 15.)

To further evaluate the data, the question of whether disability would have an effect on opportunities for employment was crosstabulated with type of disability. Before the x^2 analysis could be performed, modifications were performed to transform both data sets due to small cell frequencies. The resulting 5 X 5 crosstabulation includes 5 disability types LD, Physical, Multiple, LV/Blind, and HI and a 5 level Likert like scale from 1 (Strongly disagree) to 5 (Strongly agree).

The small number of students in the Hearing Impaired (HI) group resulted in unavoidable violations of the assumptions which underlie x^2 analysis but only for this disability group. It is

Figure 15: Perceived effect of disability on employment opportunities by disability.



therefore with caution that the calculated x^2 and p values for this crosstabulation be viewed ($x^2 = 39.51$; df = 16; $p \leq .001$).

Crosstabulation Table D

x^2 crosstab of disability groups by perceived impact of disability on opportunities for employment (observed frequencies). N = 489

	(Strongly disagree) 1	2	3	4	5 (Strongly agree)	
LV/Blind	6	5	7	9	18	45
LD	58	29	44	38	44	213
Physical	26	10	26	15	37	114
HI	2	2	4	2	3	13
Multiple	10	6	19	18	51	104
	102	52	100	82	153	489

It appears that three of the disability groups (LV/Blind, Physical, and Multiple) feel that their disability will adversely affect their opportunities for employment. This does not appear to be the case for the LD group. Due to the small N, no conclusions can be drawn for the HI group.

THIRD LEVEL DATA ANALYSIS:
STUDENT CHARACTERISTICS BY GENDER

Gender by Disability

Gender was crosstabulated with type of disability. For the purposes of this study, low vision and blind were collapsed into Visual Impairment [VI], deaf and hard of hearing were collapsed

into Hearing Impaired [HI], while other and multiple disabled were collapsed into Other [O].

Crosstabulation Table E

x^2 crosstab of gender by disability type (observed frequencies)
N = 439

	Male	Female	
LV/Blind	16	26	42
LD	102	90	192
Physical	59	49	108
HI	6	5	11
Other	46	40	86
	229	210	

This x^2 analysis was nonsignificant ($x^2 = 3.751$; df = 4; $p \leq .44$). There was a fairly equal distribution of men and women across disability groups.

Table 7

Grade Level First Introduced to Computers

	Males	Females
Between K and 6th grade..... 1	4.33%	.95%
Between 7th and 8th grade.... 2	7.36	2.37
Between 9th and 12th grade... 3	20.78	16.59
Between grades 13 and 14..... 4	29.44	34.60
After grade 14..... 5	14.72	16.11
Other..... 6	12.55	16.11
Never..... 7	10.82	13.27

There were striking differences between males and females in terms of the grade level at which they were first introduced to computers. By the end of high school, thirty-two percent

(32.47%) of males had been introduced to computers while only twenty percent (19.91%) of females had been introduced to computers. A far higher percentage of females (50.71%) are introduced to computers for the first time in a post secondary setting than are males (44.16%). (See Figure 16.)

Table 8

Grade Level First Introduced to Computers with Access

		Males	Females
Between K and 6th grade.....	1	.87%	0.00%
Between 7th and 8th grade....	2	1.75	1.00
Between 9th and 12th grade...	3	9.62	9.45
Between grades 13 and 14.....	4	30.57	31.34
After grade 14.....	5	17.47	19.90
Other.....	6	14.41	14.93
Never.....	7	25.33	23.38

There are marked differences between males and females in the grade level at which they were first introduced to computer access technologies. Whereas twelve percent of disabled males (12.24%) had been introduced to computer access technologies before completing high school, only ten percent of females had been similarly introduced. Proportionally, disabled females were introduced to computer access technologies fifteen percent (14.6%) less often than males prior to high school graduation.

The majority of females (51.24%) receive their first introduction to adapted computer access in a postsecondary setting. For males this first exposure percentage is somewhat smaller at forty-eight percent (48.04%). (See Figure 17.)

Figure 16: Grade level first introduced to computers.

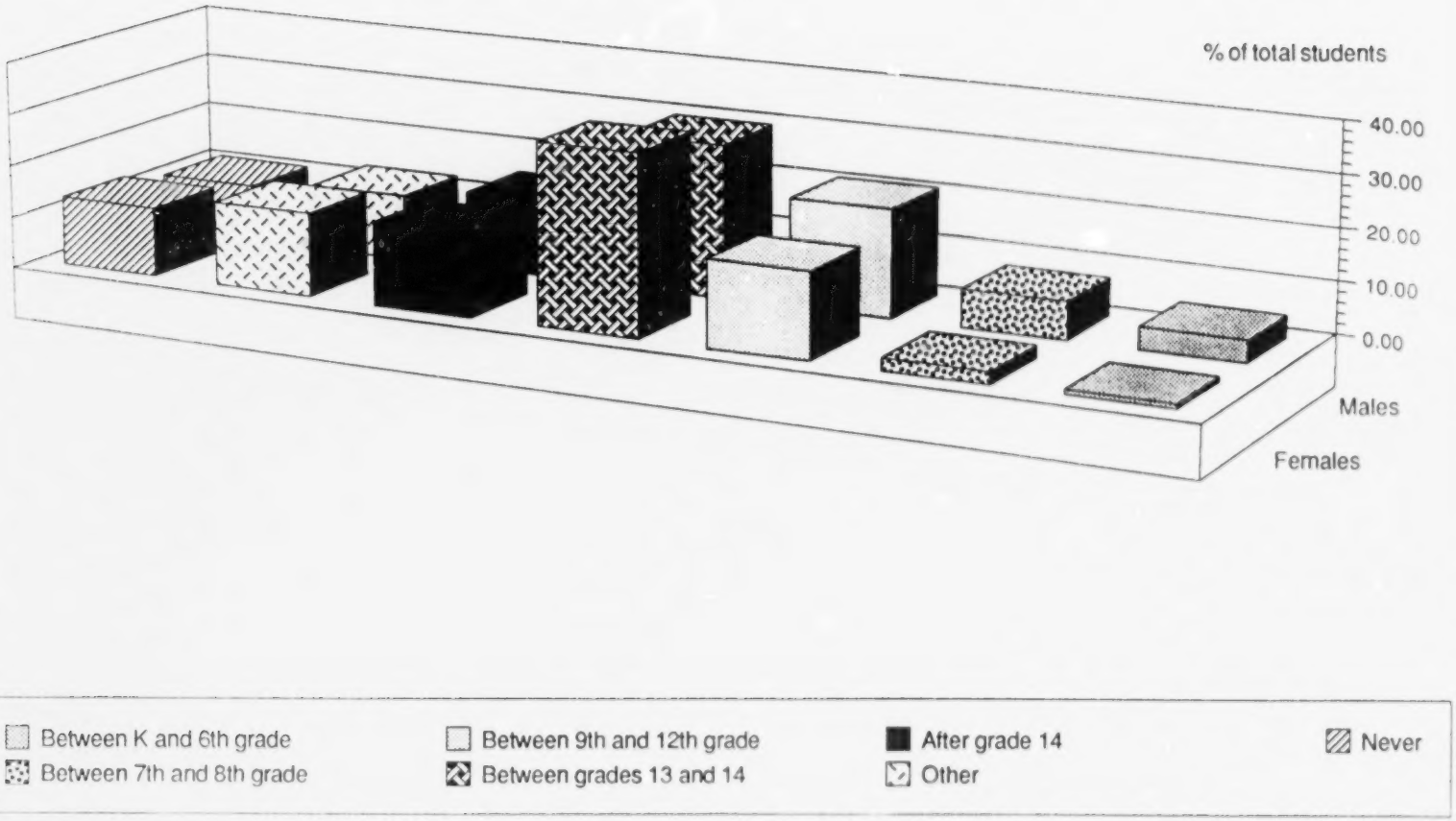


Figure 17: Grade level first introduced to computers with access.

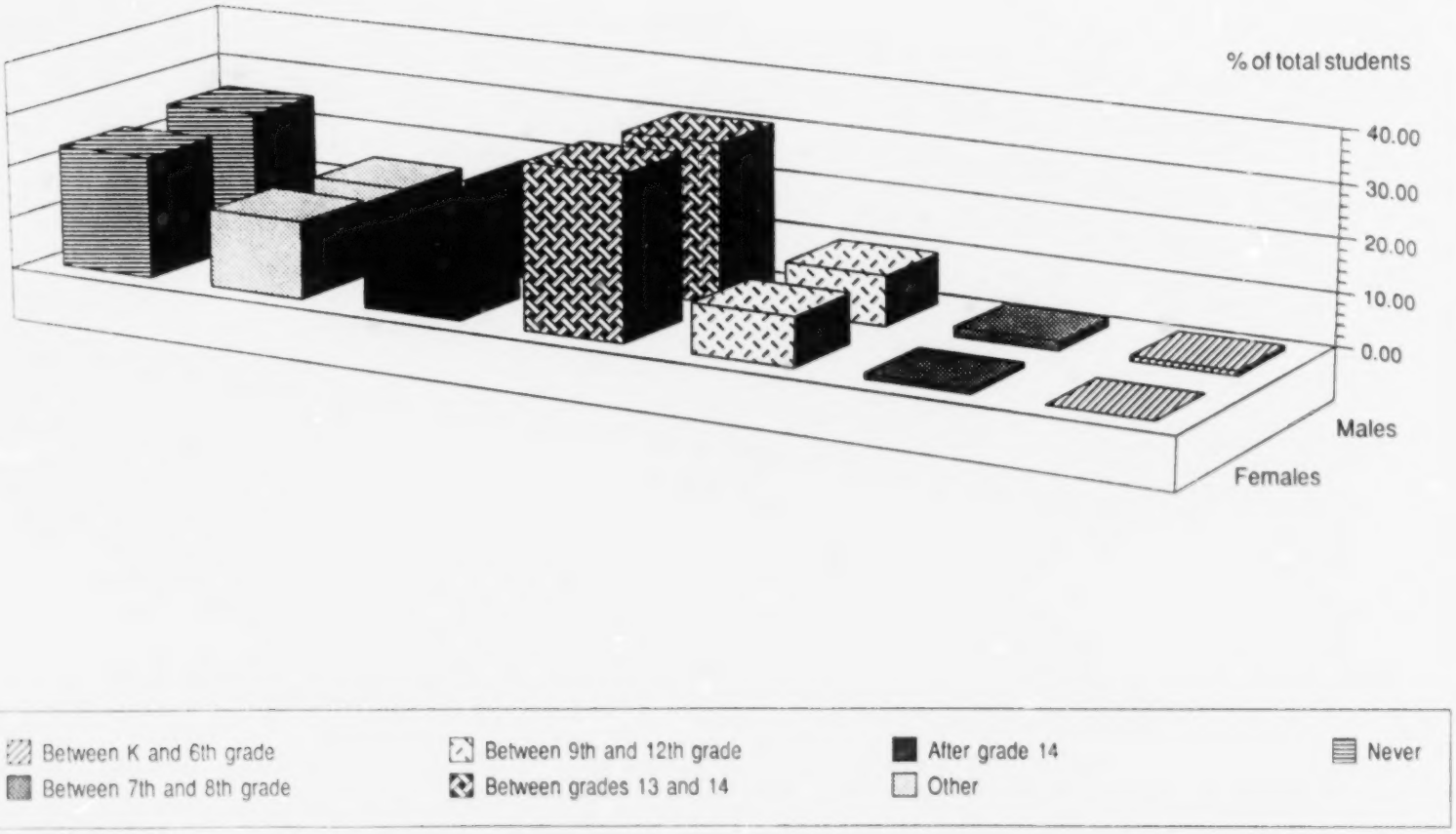


Table 9

Educational Goals

		Males	Females
Vocational certificate.....	1	10.39%	13.81%
Associate Degree + transfer toward a four year degree.....	2	25.11	21.90
Associate Degree/Vocational.....	3	7.36	9.05
Associate Degree/General Ed.....	4	6.93	8.10
Transfer courses toward a four-year degree w/o Associate Degree.....	5	8.23	5.71
Courses of personal interest.....	6	11.69	11.43
Courses related to employment.....	7	14.72	14.29
Other.....	8	3.90	7.14
Unknown.....	9	11.69	8.57

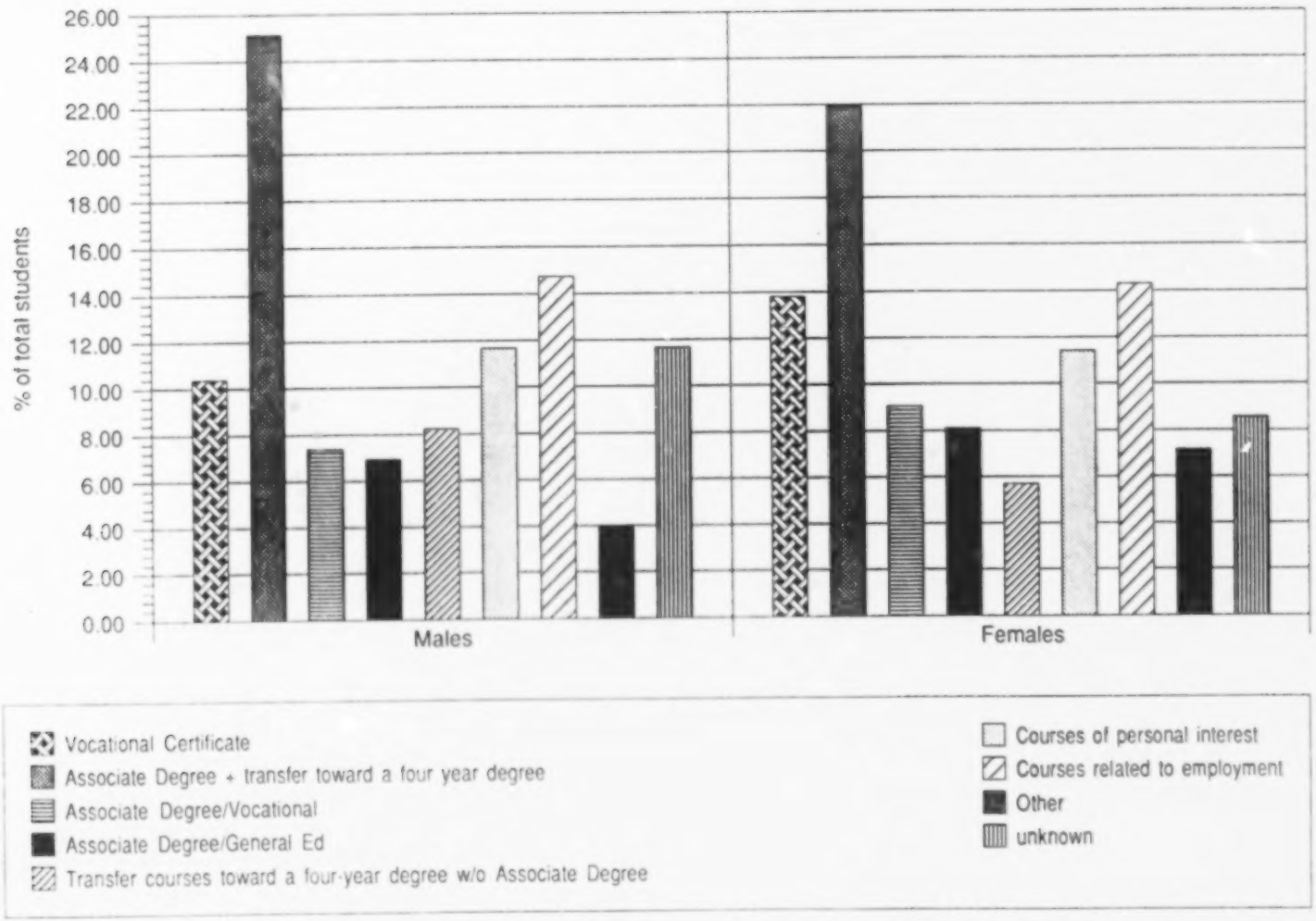
These data suggest that more disabled females (45.25%) are enrolled in vocational track or employment related courses than are disabled males (39.40%). While more than thirty-three percent (33.34%) of disabled males intend to transfer into a four year degree program, only twenty-eight percent (27.61%) of disabled females intend to transfer. (See Figure 18.)

Table 10

Reason for Enrolling in High Tech Center Course

		Males	Females
Required before I can enroll in another class I want to take.....	1	.87%	.96%
To increase my chances of success in other classes.....	2	28.57	25.00
Counselor recommended I enroll in course.....	3	10.39	12.50
For job requirements/need.....	4	10.82	16.35
For personal interest.....	5	19.48	16.83
Parent or other encouraged me to enroll.....	6	3.90	.48
Not sure why.....	7	1.30	1.92
Other - explain.....	8	6.49	5.29
Multiple reasons.....	9	18.18	20.67

Figure 18: Educational Goals



The data indicate that a higher percentage of females (16.35%) enroll in the High Tech Centers course for job requirement purposes than do males (10.82%). While nearly twenty-nine percent (28.57%) of males enroll to increase chances of success in other classes, only twenty-five percent (25%) of females enroll to increase chances of success in other classes.

Table 11

Ease of Computer Use Before and After High Tech Center Training

		Before		After	
		Males	Females	Males	Females
Difficult	10	29.44%	36.76%	3.86%	4.66%
	9	10.66	9.73	6.28	4.15
	8	9.64	7.57	7.73	4.66
	7	5.08	8.11	5.31	3.11
	6	10.15	7.57	5.31	8.81
	5	14.21	9.73	10.14	10.88
	4	3.05	7.03	7.73	16.06
	3	4.06	3.78	16.91	13.47
	2	3.55	3.78	14.98	7.25
Easy	1	9.64	5.95	21.74	26.94
		Mean = 6.85	Mean = 7.19	Mean = 4.10	Mean = 3.96
		SD = 3.12	SD = 2.92	SD = 2.78	SD = 2.66

Females made substantial gains over males in ease of computer use after High Tech Center training. Before training, the majority of females (62.17%) reported computer use as moderately to very difficult. The majority of males (54.82%) indicated that computers were moderately to very difficult to use. After training, the majority of females (63.72%) reported computer use as moderate to very easy. A smaller majority of males (61.36%)

reported computer use as moderate to very easy. Females increased their overall ease of computer use by more than seven percent (7%) over males. (See Figure 19.)

Table 12

Confidence in Staff Ability to Select Correct Computer Access Systems

		Males	Females
Strongly Agree	10	53.55%	62.98%
	9	11.37	9.39
	8	12.80	7.18
	7	8.06	8.29
	6	6.16	2.21
	5	5.69	5.52
	4	1.42	1.66
	3	.47	.55
	2	0.0	0.0
Strongly Disagree	1	.47	2.21
		Mean = 8.69	Mean = 8.81
		SD = 1.79	SD = 2.03

There did not appear to be any significant differences between the opinions of males and females in regard to staff ability to select correct computer access systems.

Figure 19: Ease of computer use before and after HTC training

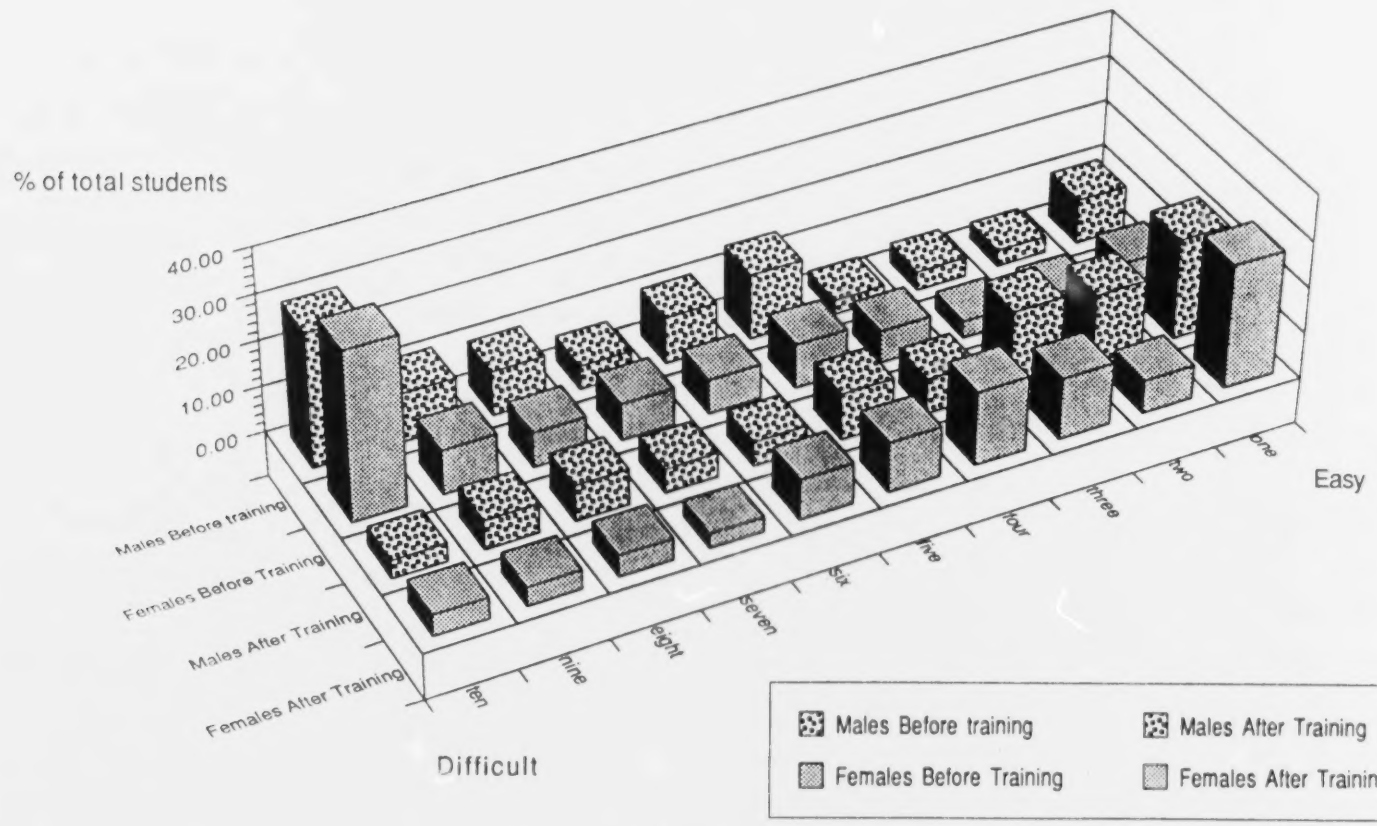


Table 13

Access to Computers will help with Graduation from College

		Males	Females
Strongly Agree	10	37.15%	39.18%
	9	11.00	8.19
	8	10.50	8.19
	7	11.00	8.77
	6	7.00	8.77
	5	8.00	7.60
	4	3.00	3.51
	3	3.50	2.34
	2	.50	3.51
Strongly Disagree	1	8.50	9.94
		Mean = 7.44	Mean = 7.21
		SD = 2.85	SD = 3.08

There appeared to be little significant difference between males and females in regard to their belief as to whether computers would help with graduation from college. The majority of both groups (Males = 69.65%, Females = 64.33%) moderately to strongly agreed that computers would be a help to graduation from college.

Table 14

Perceived Effect of Disability on Opportunities for Employment

		Males	Females
Strongly Agree	10	24.77%	23.66%
	9	8.72	8.06
	8	9.63	9.14
	7	6.88	8.60
	6	6.42	9.14
	5	10.55	12.90
	4	4.59	4.84
	3	5.05	6.99
	2	4.59	4.84
Strongly Disagree	1	18.81	11.83
		Mean = 6.04	Mean = 6.23
		SD = 3.38	SD = 3.10

Analysis of this data reveals little difference between males and females (Males = 50.00%, Females = 49.46%) in terms of those who moderately to strongly agree that their disability will have an affect on opportunities for employment. More difference is evident between males and females (Males = 16.97%, Females = 22.04%) in those persons who are uncertain what the effect of their disability will be on employment opportunities. The greatest difference between males and females is seen in those persons who moderately to strongly disagree (Males = 33.04%, Females = 28.50%) that disability will affect their opportunities for employment.

CHAPTER 5: DISCUSSION, CONCLUSIONS, AND SUGGESTIONS

DISCUSSION

This descriptive study set out to identify the characteristics of a sample of 555 students with disabilities enrolled in the California Community Colleges High Tech Centers programs. The study examined the students from three different but interrelated viewpoints: general characteristics of the entire sample, characteristics of the sample by disability type, and characteristics of the sample by gender.

General Characteristics

From analysis of the general characteristics of students with disabilities enrolled in the High Tech Centers programs, a fairly distinct picture emerges:

The High Tech Centers programs are used fairly equally by both males and females with male usage slightly ahead of female. The program is predominantly used by Caucasians, followed by Hispanics and then Blacks. A large percent (34%) of students who use the High Tech Center are generally younger (between nineteen and twenty-four years of age) than most community college going students whose average age is thirty-four. Students with learning, orthopedic, or multiple disabilities are the majority participants in the program followed by persons with visual

disabilities. The majority of students in the High Tech Centers program are very likely entering college for the first time and plan on transferring to a four-year college. Although most students enrolled in the High Tech Center program to increase their chances of success in other classes, some enrolled to improve job skills, for other or personal reasons.

Whereas students were probably exposed to computers for the first time between the ninth and twelfth grades, the High Tech Center will very likely provide a first experience with computer access technologies. Before enrolling in the High Tech Center program, students generally found computer use "moderately difficult to difficult". After completing the course, students find computer use "moderately easy to easy" and are confident in their ability to use access technologies.

With regard to the quality of instruction received, students report a high level of confidence in the ability of their instructor to answer questions relating to computer access, select correct computer access systems, and assist with special learning needs.

While quite confident in their ability to use the technology, the data analysis reveals some confusion on the student's part with regard to the importance of computer access to graduation from college. Although students generally agree that it is important, they do not agree as decisively as with other questions in this

study. This may be due, in large part, to the more youthful population of this sample and the lack of academic experience of first time college students rather than to any artifact of disability.

With regard to the effect of disability on opportunities for employment, again, results of the data analysis display some uncertainty on the student's part. Although students are clearly aware that their disability will be a factor, they appear to be uncertain as to how significant a factor it will be. Once more, this may be due, in large part, to the age of the students, probable lack of work history, and beliefs about the difficulty of finding work rather than a past record of actual employment experience.

In summary, the students in this study are seen to be somewhat younger in age than the majority of community college students. Although the mean age of students in this sample is thirty-two (32) years, the population of older adults included in the study causes this number to be misleading (SD = 12.22). These students are most likely entering Freshmen who are attending college for the first time or older students who are re-entering postsecondary education.

The ethnic minorities in this study are underrepresented in relationship to the state's general college going population, while Caucasians are overrepresented. Although, to some extent,

this may be due to differing cultural responses to disabling conditions, the observed pattern of minority underepresentedness of students with disabilities is consistent with the under-representedness of ethnic minorities in the community college system in general (Kanter, 1989).

It is also interesting to observe that while the majority of disabling conditions occur prior to age eighteen, (the mean age is 11.5 years with most disabilities occurring at birth), for most students in this study, the High Tech Centers will probably be their first exposure to both computers and computer access technologies. The majority of persons in this study will have passed through the most critical years of their education without access to computers.

Characteristics of Students by Type of Disability

The data in this study were analyzed to determine if any demographic characteristics, patterns of educational history, academic goals, or levels of program satisfaction were unique to a particular disability group or groups.

Students in this study who have learning or physical disabilities are predominantly between eighteen and thirty-four years of age with the majority of students ranging from eighteen to twenty-four years of age. The "bulge" in the eighteen to twenty-four year old age range is common to the majority of disability types

considered in this study. This may reflect expanded efforts made over the last ten years by state and federal agencies to improve educational and college transfer opportunities for students with disabilities in the K-12 systems.

The population of blind or low-vision students in the sample are generally older. This suggests that their disabilities were acquired later in life, perhaps as a result of a progressive disorder. Although this seems particularly true of blind students, students with low-vision appear to be equally divided between "typical" college age students and older adults.

Across all ethnicity groups, learning disability is the single most common disability type. Although the sample size for Hispanic and American Indian students in this study is relatively small, these two groups appear to have unusually high percentages of learning disabilities in relationship to the total group of students with disabilities in this sample.

Physical and multiple disabilities are, respectively, the second and third most common disability types across all ethnicity groups. With sample sizes of ($n < 4$) excluded from the analysis, Black students have the highest percentage of physical disabilities while Asian students have the highest percentage of multiple disabilities. Asian students in this study have dramatically higher percentages of low-vision and blindness than any other ethnic group.

No clear patterns emerge with regard to educational goals by type of disability. It appears that the students in this study are virtually indistinguishable from the general group of community college-going students in their educational goals although a somewhat larger percentage of students with disabilities are enrolled in courses of personal interest. This "personal interest" group may well represent the population of older adults who frequently qualify for enrollment in the High Tech Center program.

With regard to improved ease of computer use after the High Tech Center training, major gains were made by all disability types. Low-vision and blind students report the greatest gains in ease of computer access followed next by students with physical and then learning disabilities. This is due most likely to the specificity and sophistication of access systems for low-vision, blind, and physically disabled versus the more generalized types of computer access systems available for students with learning or other types of disability.

Although all disability groups report high levels of confidence in their ability to use special access systems, again, low-vision, blind, physically, and learning disabled students report the highest levels of confidence. This is, perhaps, a powerful indicator of the effectiveness of computer access systems which have been designed to meet the specific needs of particular

disability groups; specifically low-vision, blind, and physically disabled.

In responding to the question of the perceived effect their disability will have on opportunities for employment, students in each disability group have quite distinct opinions.

Persons with multiple disabilities strongly agree that their disability will have a considerable effect on opportunities for employment. In analyzing the responses of this group across the entire number of students in this study, it is evident that although gains have been made, these gains were not as large as those of other disability groups. The actual and perceived disadvantagement of this group is clearly higher than that of other disability groups. Many members of this group may be severely as well as multiple disabled. These results suggest that community colleges and other agencies which serve the multiple disabled may want to expand counseling and related transition-to-work services for these individuals.

At the opposite end of the spectrum, students with learning disabilities expect to experience relatively little impact of disability on opportunities for employment. There very well may be a relationship between the visibility of the disability and the student's perceived effect of the disability on opportunities for employment. Whereas students with "invisible" disabilities such as learning disabilities, deafness, diabetes, respiratory,

or heart conditions perceive their disabilities to have little effect on opportunities for employment, students with highly visible disabilities such as physical, visual, or neurological limitations (either singly or in combination) anticipate much more impact on employment opportunity.

Characteristics of Students by Gender

Although evaluation of the data by gender reveals a fairly even distribution of men and women across disability groups, a slight tendency towards males with learning disabilities can be observed. This is consistent with gender distribution findings of students with learning disabilities in other studies. In regard to low-vision and blind students in the sample, even though females with visual disabilities outnumber males by nearly two to one, the small sample size may account for this finding.

A much more important finding concerns major differences in the grade levels at which males and females with disabilities were first introduced to computers. Whereas thirty-two percent (32%) of males had been introduced to computers before the twelfth grade, only twenty percent (20%) of females had been similarly introduced - a twelve percent (12%) difference. At such a critical period in the educational process, this could represent a major obstacle to future academic performance.

For the disabled males and females who received an introduction to computer access technology prior to high school graduation, twelve percent (12%) were males and ten (10%) were females. Proportionally, fifteen percent (15%) fewer females than males had access to computer access technology prior to high school graduation. These findings suggest that females appear to be at a disadvantage in that fewer are introduced to computers and computer access during their high school years. The low incidence of computer exposure (particularly for females) could have serious impact on subsequent educational preparation and performance.

What is evident from this study is that the majority (at least 60%) of male and female students with disabilities receive their first introduction to both computers and computer access technologies in a community college setting and most likely at a High Tech Center for the Disabled.

This study reveals a tendency for disabled females to enroll in vocational track or employment related courses more frequently than males. Also, disabled females appear less likely to enroll in courses leading to transfer to four year degree programs than disabled males. These findings suggest that colleges may want to provide additional counseling directed at disabled females entering college for the first time. It is also possible that this study may be identifying increasing numbers of older

disabled females returning to college for retraining or to improve job skills.

In examining ease of computer use for males and females before and after the High Tech Center training, females report considerably higher levels of difficulty with computer use than males before training but greater ease of computer use than males after training. Initial high levels of difficulty in disabled females may be due in part to lack of exposure to computers in the K-12 system. Increases over disabled males in ease of computer use after training remains unexplained and may be investigated in future studies of this type.

Males and females appear to differ only slightly in regard to their high levels of confidence in the ability of High Tech Center staff to select appropriate computer access technologies, a moderately strong belief in the importance of computer access to help with graduation from college, and a moderate belief (with females slightly more uncertain than males) that disability would affect opportunities for employment.

CONCLUSIONS

In some respects, what is most striking about the students in this study is their similarity to able-bodied community college students. Their ages, ethnicities, and educational goals are virtually indistinguishable from the overall statewide population of non-disabled, community college going students.

As is the case on many community college campuses, disabled ethnic minorities remain seriously underrepresented even as subsets of minority populations on campus.

Although a higher percentage of disabled than non-disabled students enroll in community college courses for personal interest or other reasons, this is consistent with the goals of older adult populations participating in programs for students with disabilities as well as the "life-long learning" offerings on many community college campuses.

The perceived impact of disability (particularly highly visible disability) on opportunities for employment appears as a real and troubling issue for students in this study. The effects of this perception may have a strong impact on the vigor with which such students work to prepare themselves to become employable. High Tech Center training may help to increase a student's confidence in his/her personal and professional marketability and thus

reduce the negative impact of such perceptions on the academic performance of disabled students.

Students participating in the High Tech Centers program appear to have great confidence in the professional ability of High Tech Center instructional staff. Across all ethnic, gender, and disability groups, students make substantial gains in the ease and confidence with which they can use microcomputers. These gains should be readily observable in future studies as they are translated into improved academic performance, higher rates of transfer to four year colleges, and enhanced job placement over the coming years.

The California Community Colleges' program of High Tech Centers for the Disabled appears to play a major role in introducing persons with disabilities to both computers in general and computer access technologies in particular. For the overwhelming majority of students in this sample, ranging from eighteen to thirty-four years of age, the High Tech Centers will most likely provide their first opportunity to learn both computer usage and the operation of computer access technologies. This is a tremendous responsibility as well as an enormous opportunity for the High Tech Centers programs.

SUGGESTIONS

As with many descriptive studies, these findings may raise as many questions as they answer. Among the important issues reserved for future studies are:

1. The long term effects of access to computer technology on the academic performance of students with disabilities. The next logical extension of this study would be a long-term study to track the performance of students with computer access versus those without computer access would be very informative.

2. The perceived impact of certain highly visible disabilities on opportunities for employment may have substantial negative impact on the students' willingness to work hard in preparation for the working world. Additional studies might profitably examine this relationship to better counsel students in preparation for successful employment.

3. The integration of computer access technologies into the postsecondary educational setting is very much in its infancy. A careful and methodical evaluation of the steps necessary to implement a guaranteed level of computer access at California community colleges on a state-wide basis is clearly called for.

4. This study may have revealed the continuing existence of gender inequity in the K-12 educational system with regard to computer technology and access. An additional study to further explore this finding would be worthwhile.

5. This study clearly revealed the extent to which the High Tech Centers program provides the majority of students with disabilities a first opportunity to learn about and use computers. The value of this discovery cannot be overstated. If the data in this study hold true for the remaining fifty -six community colleges which do not presently have High Tech Centers, then it is reasonable to assume that the majority of disabled students in those colleges have received little if any training in computers and computer access systems. It is vitally important to both the academic and employment futures of these students that High Tech Centers be established on their campuses as quickly as possible.

The data collected for this study remain a rich source for additional research. A study examining all of the variables incorporated into this study but limited to students between eighteen and twenty-four years of age might well identify many unique characteristics of younger students just entering the community college system. It is most likely that such a population would be more technologically sophisticated and have higher expectations of instructors with regard to computers and access systems.

California's rapidly changing demographic make-up points unflinchingly towards a tomorrow in which the unique characteristics and needs of diverse ethnic and social groups will be the norm rather than the exception. Within this rapidly changing structure, there exists an unprecedented opportunity for persons with disabilities to establish a claim on the availability and shape of a computer technology which will sculpt the future of our lives into the far distant future. The time to change the future is now.

REFERENCES

Assembly Bill No. 77 (1975-76 Reg. Sess.) The Lanterman act.

Assembly Bill No. 1725 (1987-88 Reg. Sess.) Community colleges.

Bozeman, W. C. (1988, February). Microcomputers in education: The second decade. T.H.E Journal, 82-86.

Brown, C. (Ed.). (1986, December). Computer Access in Higher Education for Students with Disabilities. (Available from The High Tech Centers for the Disabled, 1109 9th Street, Sacramento, California, 95814)

California Community Colleges Chancellor's Office. (1988). Budget change proposal, Disabled Students Programs and Services. Sacramento, CA: Author.

Couch, J. G. (1987). The physically challenged, the computer, and the community college. In H. Murphy (Ed.), Proceedings of the third annual conference on Computer Technology/Special Education/Rehabilitation (pp. 169-178). Northridge, CA: California State University, Northridge.

Engen-Wedin, N., Margolis, W., & Collins, T. (1987). Micro-computer word processing and LD college writers: An analysis of outcomes. Proceedings of the 10th annual conference of the Association on Handicapped Student Service Programs in Postsecondary Education, 171-177.

Harris, L., & Associates, Inc. (1986). The ICD survey of disabled Americans: Bringing disabled Americans into the mainstream, a nationwide survey of 1,000 disabled people. New York, NY: Author.

Harris, L., & Associates, Inc. (1987). The ICD survey II: Employing disabled Americans. New York, NY: Author.

Horn, C. A., Shell, D. F., & Severs, M. K. (1987). Survival skills for disabled college students: Computer technology and cognitive skills training. Proceedings of the 10th annual conference of the Association on Handicapped Student Service Programs in Postsecondary Education, 7-12.

Kanter, M. J. (1989). An exploratory study of the relationship of demographic, institutional, and assessment factors affecting access to higher education for underrepresented students in the California Community Colleges. Unpublished doctoral dissertation, University of San Francisco.

Rehabilitation Act of 1973 (Section 504), 29 U.S.C. Sections 706 and 794 (1973).

Rehabilitation Act of 1973 as amended (Pub. L. 99-506, Section 508), 29 U.S.C. 794d (1986).

Saka, T. (1986). The importance of keyboarding skills in computer usage with the handicapped. In H. Murphy (Ed.), Proceedings of the third annual conference on Computer Technology/Special Education/Rehabilitation (pp. 297-305). Northridge, CA: California State University, Northridge.